LIBRARY SEP 1 1929

ENGINEERING AND
MINING JOURNAL

METAL AND NON-METALLIC MINING · MILLING · SMELTING · REFINING · MARKETING

McGRAW-HILL PUBLISHING COMPANY, INC. August 31, 1929 TWENTY-FIVE CENTS PER COPY

Treating Cupriferous Precious-Metal Ores by the Cyanide Process

By A. C. Halferdahl

Bauxite Mining in British Guiana

By Lawrence Litchfield, Jr.

Beginning Next Week:

A series of articles on the Copper Deposits of Northern Rhodesia

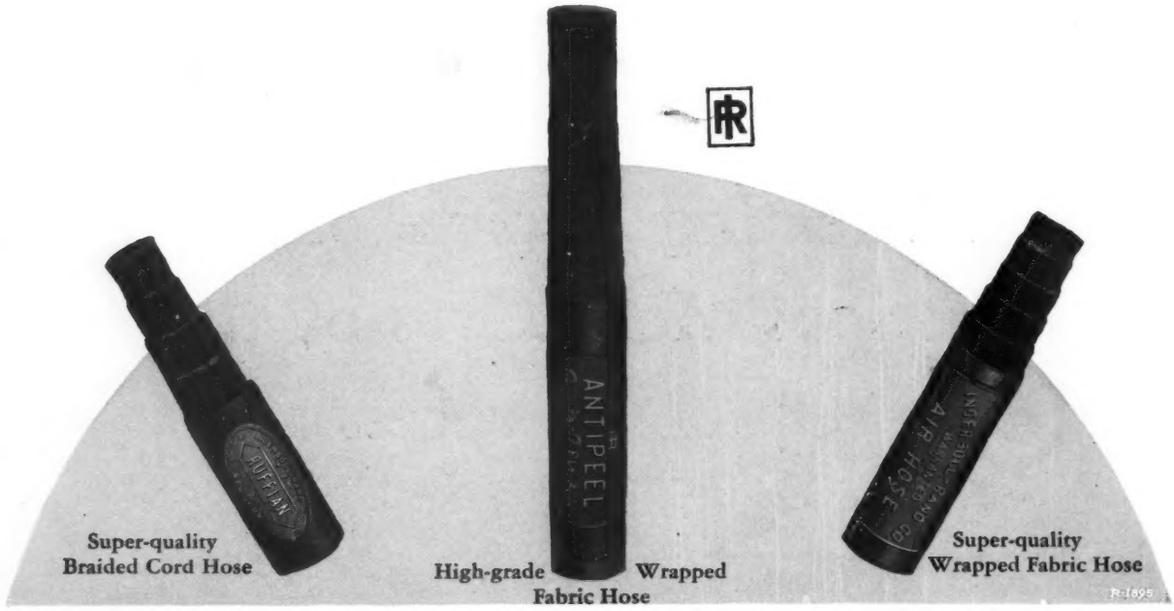
By Anton Gray and R. J. Parker, of Rhodesian Selection Trust, Ltd.

Are You Getting 100% Hose Service?

Users of air hose are entitled to 100% service. Ingersoll-Rand hose is made to give this service.

It is built to meet specific conditions on the job, and it is noted for its toughness and long life.

I-R hose is scientifically made in both the braided cord and wrapped fabric types. To help you select the proper style for your job, we shall be glad to have an I-R representative go over your hose problem. *Be sure you are getting maximum hose economy.*



RUFFIAN

A brown rubber-covered hose for quarries, mines, contracting, and general rock drill work. Built to stand up under severe wear, abrasion, kinking and crushing, and to counteract the effects of heat and oil in the air.

ANTIPEEL

A strong, light, flexible hose for general pneumatic tool work. Particularly suitable for railroad right-of-way use. Built to resist the effects of heat and oil under average operating conditions. This hose is an exceptional value for the money.

I-R AIR DRILL

An extra-strong, tough hose for general use with rock drills, pneumatic tools, and other compressed air devices. Built to resist severe outside wear and abrasion, and to offer the maximum resistance to oil and heat in the air.

INGERSOLL-RAND COMPANY - 11 Broadway - New York City

Branches or distributors in principal cities the world over

For Canada Refer—Canadian Ingersoll-Rand Co., Limited, 10 Phillips Square, Montreal, Quebec

2-H

Ingersoll-Rand

ENGINEERING AND MINING JOURNAL. August 31, 1929. Vol. 128, No. 9. Published weekly. McGraw-Hill Publishing Company, Inc., Tenth Avenue at 36th Street, New York, N. Y. United States, $6 a year; 25 cents a copy. U. S. Possessions, Canada, Mexico and the countries of Central and South America, $7.50 a year. All other foreign countries, $10 a year. Entered as second-class matter, June 20, 1879, at the Post Office, New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A.

Volume 128

ENGINEERING AND MINING JOURNAL

Number 9

A consolidation of "Engineering and Mining Journal" and "Mining and Scientific Press"

A. W. ALLEN, *Editor*

Associate Editors: E. H. ROBIE, A. H. HUBBELL, New York. GEORGE J. YOUNG, San Francisco
Assistant Editors: W. N. P. REED and H. D. KEISER, New York. *Market Editor:* H. H. WANDERS. *Publishing Director:* H. W. CLARKE

Contents

Copyright, 1929, by McGraw-Hill Publishing Company, Inc.

August 31, 1929

Editorials	343	Mining News	367
Bauxite Mining in British Guiana—II By Lawrence Litchfield, Jr.	346	Market and Financial News	375
		Indicators of Industrial Activity	377
The Problem of Treating Cupriferous Precious-Metal Ores by the Cyanide Process By A. C. Halferdahl	350	Market Report	378
Useful Operating Ideas	359	Mining Stocks	380
Comment and Criticism	361	Service Directory	20
Industrial Progress	364	Searchlight Section	21-3
Personal Notes	366	What and Where to Buy	24-6
Obituaries	366	Advertising Index	28

The Printer's Influence on Progress

THROUGH countless centuries of old time, from pyramid building to cathedral building, civilization limped along, dragging one foot wearily after the other, unmindful of passing years, ignorant of the thought world, and not suspecting the possibilities of the common man. Then came the printer, heaven-appointed prophet of the new ages to be, opening the doors to worlds unknown. Civilization leaped forward, alive and eager, romping through the years, scattering new ideas with a prodigal hand as seeds into the fertile soil of human possibility. Today, thanks to the printed word, the common man, conscious of his powers, may look upon a broader horizon than did the wisest men of old. Tomorrow, perchance, the sky will brighten into an unclouded day in the march of human progress—a day infinitely more worthy of the cumulative efforts of the ages.—Taken from an advertising folder issued by the Reading Paper Mills, Reading, Pa., as presented in *The Inland Printer* for August, 1929.

McGRAW-HILL PUBLISHING COMPANY, INC., Tenth Ave. at 36th St., New York, N. Y.

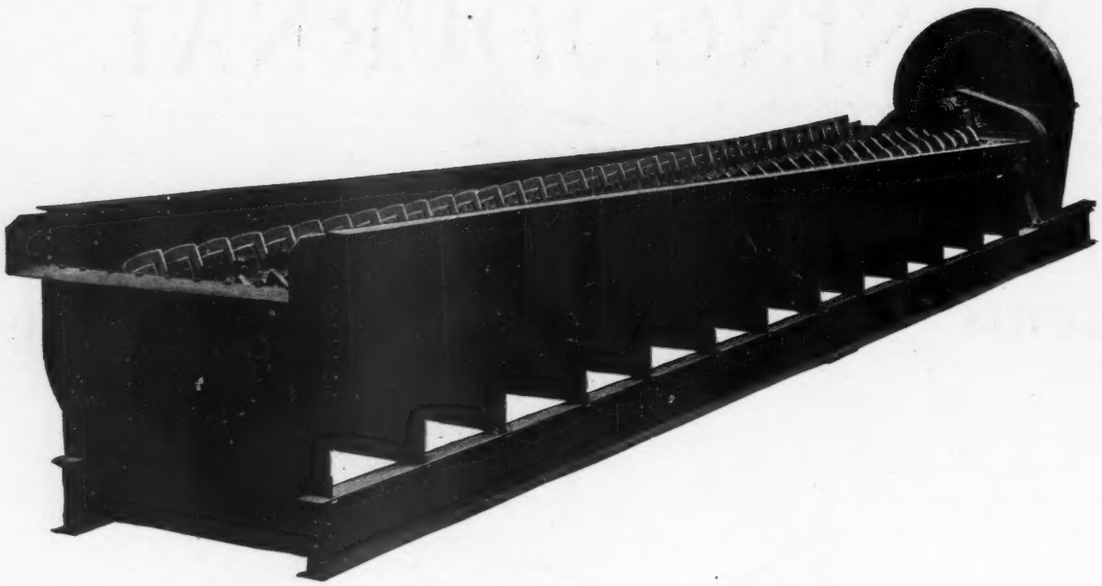
JAMES H. McGRAW, Chairman of the Board
MALCOLM MUIR, President
JAMES H. McGRAW, Jr., Vice-Pres. and Treas.
EDWARD J. MEHREN, Vice-President
MASON BRITTON, Vice-President
EDGAR KOBAK, Vice-President
HAROLD W. McGRAW, Vice-President
H. C. PARMELEE, Editorial Director
C. H. THOMPSON, Secretary

Member, Audit Bureau of Circulations, and Associated Business Papers, Inc.

NEW YORK District Office, 285 Madison Ave.
WASHINGTON, National Press Building
CHICAGO, 520 North Michigan Avenue
PHILADELPHIA, 1600 Arch St.
CLEVELAND, Guardian Building
ST. LOUIS, Bell Telephone Building
SAN FRANCISCO, 883 Mission St.
BOSTON, 1427 Statler Bldg.
GREENVILLE, S. C., 1301 Woodside Bldg.
DETROIT, 4-257 General Motors Building
LONDON, 6 Bouverie St., London, E. C. 4.

11,117 Copies Printed This Issue

Total Number of Issues to Date 3,297



LOG WASHERS

For

IRON, MANGANESE and OTHER ORES, GRAVEL, CRUSHED ROCK, Etc.

Allis-Chalmers Products

Steam Engines
Steam Turbines
Condensers
Gas Engines
Hydraulic Turbines
Oil Engines
Blowing Engines
Electrical Machinery
Pumping Engines
Centrifugal Pumps
Mining Machinery
Metallurgical Machinery
Crushing Machinery
Cement Machinery
Flour Mill Machinery
Saw Mill Machinery
Air Compressors
Air Brakes
Steam and Electric Hoists
Farm Tractors
Power Transmission Machinery
Timber Preserving Machinery

ALLIS-CHALMERS

MILWAUKEE, WIS. U. S. A.

ENGINEERING AND
MINING JOURNAL

A McGRAW-HILL PUBLICATION — A. W. ALLEN, *Editor* — ESTABLISHED 1866

VOLUME 128 — *New York, August 31, 1929* — NUMBER 9

Help Wanted—Male

THE Editor of *Engineering and Mining Journal* wishes to get into communication with an engineering graduate desirous of adopting technical journalism as a profession, with headquarters in New York. The age of those replying should not indicate the possession of set convictions and mental habits that would prevent a willing co-operation, without question, in a strict observance of the rules and practices of a publishing house, or suggest objection to a discipline in matters of routine and typographical and literary style that has for its purpose the benefiting of all concerned. A background of operating experience in mine, mill, or smelter is essential—the broader the better; and such experience should have extended beyond the confines of any one country. Purpose and character are sought, irrespective of nationality; but American citizenship, actual or definitely prospective, is an essential qualification.

A rapid internationalization of the mining industry and the gradual but sure removal of barriers that hinder world progress in that industry are serving to throw additional responsibilities on the shoulders of the staffs of technical journals of standing and influence. The qualifications of an engineer who seeks a career in technical journalism—beyond those that are obvious—are not easy to define, being complex and intangible. But such qualifications may be said to include the scientist's love for truth and accuracy; the engineer's ideal of efficiency and the avoidance of waste; the writer's respect for brevity and clarity; an evenness of temper that suffers, perhaps not gladly but without visible or expressed irritation, the actions and comments of those who bear out the truth of the saying that a little learning in any one subject, not excluding the business of publishing, may be dangerous; an intolerance of mediocre performance—not of mediocrity—without prejudice to a sense of personal humility; the journalist's recognition of the value of timeliness and an appreciation of the loss, moral as well as material, occasioned by procrastination; and the sane man's respect for the voluntary observance of those decent manners that lie midway between selfishly taking advantage of a liberty of opinion in expression, on the one hand, and having to submit to supervisory control or prohibition, on the other.

The foregoing is meant to indicate a definite philosophy of occupation and outlook, not to serve as a description of the virtues of a paragon. It may be considered as having been worded to elicit a response indicative of a sympathetic agreement with an ideal rather than an actuality. Nevertheless, the mining industry possesses a multitude of young engineers who consistently and perhaps unconsciously subscribe to such a code of ethics in their daily work. If such a statement of desirable qualifications prevents aspirants of the other type from evincing further interest in an editorial career, one purpose of this invitation will have been achieved.

As to the position itself: No other field of human endeavor affords greater opportunities for that personal service and contribution to the social and industrial well-being of humanity, without which professional work lacks ethical appeal and justification.

All communications on the subject will be considered confidential and should be addressed to the Editor and marked "Personal"

Progress in the Warfare Against Corrosion

CORROSION has been called the enemy of industry. But what a friend an enemy can be! Without enemies man would never have reached the present stage of his development, but long ago would have lost his soul in fatness and self-complacency. Enemies, once detected, arouse alertness, quicken the perceptions, and stimulate ingenuity. Corrosion causes waste and loss, but its ravages spur man to new creation, and in the end the score of his achievement is greater than before.

Witness the accomplishments of recent years. Once awakened to the toll exacted by corrosion, industry set out to fight it. Individuals beheld in it a challenge and a chance to win recognition, just as the young man of the past saw in war a road to fame and fortune. Corrosion still ravages, but less extensively than before. Means of overcoming the enemy have been devised and are being multiplied. They are of devious sorts.

Paints and other coatings, obvious remedies for corrosion, though having their limitations, first received attention. Substitute materials—rubber, wood, porcelain, cement—have since come into use to replace or protect vulnerable metals that otherwise would be directly in contact with the enemy. But the prime achievement is the ever-growing list of metals and alloys which will not corrode, or at worst corrode but slowly, and which are now offered to take the place of those that yield rapidly to corrosion. These are the shock troops in the combat. By such means the war is being fought.

Evidences of the fight are visible to all, even if those who see them may not in every case appreciate the underlying purpose. The operator finds materials of superior, lasting qualities available for many different purposes. The householder has beheld the increasing substitution of copper, zinc, and brass for iron in dwellings, and now demands them because he readily understands the advantages of the change. The housewife, too, buys cutlery that will not stain, and finds it more pleasing and convenient. Citizens of a Western city are now admiring a pedestrian bridge that adorns their town. Roof and sides of the covered structure are of glistening, silver-white metal, beautiful to the eye. But rather for its resistance to the weather was the chromium-nickel-iron alloy composing it selected. Inasmuch as attractiveness and utility combined furnish a persuasive selling argument, wider use of such alloys may be expected.

What profit is there in this warfare on corrosion? In dollars and cents the net cannot be estimated. The operator benefits by using a corrosion-resisting metal, although at the outset he may pay a higher price. But as one individual gains, another may be losing. This has always been the case as society has progressed. Rapid waste of material by corrosion and its replacement by more of the same material profits the maker of that material; but if corrosion be prevented, this particular manufacturer's sales will suffer, unless in the meantime he also begins to make a better corrosion-resisting product. Thus one industry wanes as a new one waxes, and eventually some long-used products may completely disappear from the market. Of this the progressive manufacturer is aware, and prepares himself to meet any change in the character of demand where change seems likely. Noteworthy in this respect is the act of certain steel companies in securing licenses recently to make a rustless steel. Looking ahead, it is not difficult to visualize a day when the demand for any steel except one of a non-corroding sort will be considerably less than now, and when, for example, no one will think of using gutters, leaders, and sheets of galvanized iron for any but temporary structures.

But society profits from the warfare on corrosion, whether or not some industries may suffer as others grow. Waste is being eliminated to a greater and greater extent, thereby minimizing the drain upon resources of raw materials. Better and more lasting machinery and structures are being built and will be possible. Society, so far as its material civilization is concerned, ascends another step or two.

Will the White Man Carry His Own Burden in Rhodesia?

SOME TIME AGO *Engineering and Mining Journal* made the suggestion that the distressing unemployment situation in Great Britain might be ameliorated by the transportation of miners from the affected coal areas of Wales and northern England to the Witwatersrand district of South Africa and to the new copper fields in Northern Rhodesia. Therefore we note with especial interest that, at the ordinary general meeting of Bwana M'Kubwa Copper, Sir Edmund Davis, the chairman, indicated that the company was taking such action. Should the men now being transported prove satisfactory, he declared, employment for a fairly large English mining population would be found in Northern Rhodesia.

The white man has not infrequently been charged with corrupting the inhabitants of other lands, the resources of which he has chosen to exploit. Mr. Stuart Chase, in "Men and Machines," states that "The impact of the machine on nature peoples has been an unrelieved story of progressive degeneration." This view may be a trifle too broad, but the exceptions are few and far between. Even the most considerate treatment of colored workers by the copper companies is hardly likely to compensate for the loss of freedom that accompanies the change from a sedentary to an industrially productive people. A suspicion has been growing that the "White Man's Burden" is largely self-imposed. The load has not been "wished" on him by other races.

Apart, of course, from humanitarian considerations—which are not always uppermost in the thoughts of mining magnates—operation of the Rhodesian mines entirely or largely by white miners has economic potentialities. Union Minière, immediately north of the Rhodesian belt, has experienced difficulty in maintaining its force of black labor to the number required for the desired rate of operation. In fact, for this reason, the company was unable to increase its output as quickly last autumn as did the other large copper producers. South of Rhodesia are the Witwatersrand mines, which have been troubled by a shortage of colored workers for several years. Recently the Transvaal authorities had to make an agreement with Portuguese officials whereby the supply of labor from Mozambique will be reduced each year. "There can be no argument as to the seriousness of the native labor problem," writes Mr. Owen Letcher, our

Johannesburg correspondent. At the last quarterly meeting of the Transvaal Chamber of Mines, Mr. John Martin, the president, stated that the contraction in profits of Rand mines during the first six months of 1929, compared with 1928, clearly shows how a scarcity of colored labor is affecting the mining industry.

To secure native workers, the Rhodesian mines will have to initiate recruiting campaigns, and those secured may not stay longer than the period of their indenture. If the Rhodesian mines are to depend chiefly on black labor, they will run the risk of being forced to decrease production every time a shortage of new workers occurs.

A social prejudice that undoubtedly exists against the joint performance of manual labor by blacks and whites has played its part in keeping down to a minimum the number of white miners on the Rand. No prejudice exists, however, against the performance of manual labor solely by whites. If work in the United States can be accepted as an example—and with the adoption of thorough mechanization in Rhodesia it can be—not more than 10,000 English miners would be needed to operate completely the six Rhodesian mines now under development. In Arizona, about 15,000 men, employed at eleven large mines, are producing at the rate of 450,000 tons of copper a year. Many of these workers are Mexicans and are probably not as efficient as English workers would be under similar circumstances. Although employing more workers than all the Arizona mines combined, Union Minière has hardly one-third the output of the Apache State. Mr. Ramsay MacDonald and his new Labor government, chosen to direct the affairs of Great Britain to a large extent on the strength of pledges to end unemployment, might do well to investigate more thoroughly this possible outlet for unemployed British miners and to bring the subject to the attention of all the operating companies.

Substitutes for High Priced Industrial Metals

NO HIGH-PRICED METAL is safe from the effect of substitute competition. Platinum, in particular, has been the victim of many successful efforts in the laboratory to isolate or to synthesize other elements and to produce a commercial metal or alloy that would possess similar properties. The metallurgical history of tantalum exemplifies this tendency, and the new metal has found wide application, particularly for laboratory ware. More recently, Dr. E. F. Lowry, of Ohio State University, developed a substitute for platinum, which has been named konel, for use in radio tubes. Reports affirm that filaments of the new metal, the identity of which has not been disclosed, have an especially long life. The tubes, operated at a lower temperature than those with platinum filaments, give the same emission but better reception results.

Invention leads to experimentation. Konel was found to retain its toughness at a temperature at which most metals lose their strength. Its application in the construction of the moving parts of internal-combustion engines followed, and in other places where high temperatures prevailed, according to a recent announcement by the Westinghouse company.

A broader field of usefulness resulted, in consequence of which konel will probably be sold by the pound instead of by the ounce. Its application for radio filaments will promptly become of secondary economic significance. Greater production, expanded application, and larger consumption combine to make possible the lower price that in turn is an important factor in assuring a sound and successful industrial venture. The implied lesson, if taken seriously, would correct many examples of market stagnation in other industries.

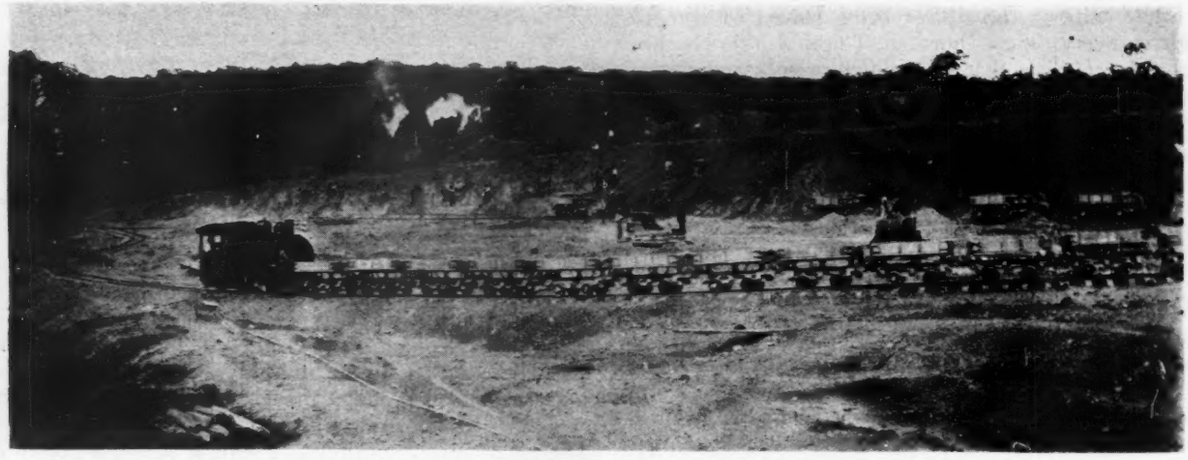
Perfecting Technique in Relief Maps and Models

MODELS of mine workings and geological features, as well as relief maps of various types, have been used for many years to disseminate knowledge of the physical characteristics of the mining industry. Educational institutions, particularly, have made recourse to such equipment, so that the student might clearly visualize in three dimensions certain portions of several subjects presented in his courses of study, such as mining methods, structural geology, and plant layout. Moreover, much of the litigation in the industry relative to mineral rights has been settled with the aid of the easily understood evidence made available by such duplicates in miniature of underground ore deposits and workings.

In connection with the manufacture and source of such equipment, many members of the industry, especially engineers and geologists, will be interested to learn of the attention that a Munich enterprise is attracting from numerous government offices, cities, schools, mining companies, geological societies, and various industries in all quarters of the globe. This organization is the Kartographische Relief Gesellschaft and Deutsche Hochbild Gesellschaft combine. Kartographische Relief controls the Wenschow invention for the production of relief maps. By this process, flat maps, printed on special paper, are stamped into relief in hard, weatherproof material, and, by means of the mold thus formed or the matrix cast from it, an indefinite number of copies of the relief map can be reproduced. Deutsche Hochbild produces in minute detail relief models of cities, industrial plants, mines, geological structures, and similar subjects. The joint company, formed in 1920, has trained its skilled personnel for the work, which requires intelligence, conscientiousness, and a better than average education.

Rights to the Wenschow process are being sought by interests in nearly all countries, including the United States, England, Australia, Japan, Spain, Italy, Jugoslavia, Poland, Russia, Turkey, Argentina, Peru, and Chile; and Deutsche Hochbild relief models, owing to their distinctive qualities of exceptional accuracy and durability, enjoy a world-wide distribution that continues to increase steadily. Truly, Hubbard's observation anent the mousetrap is well exemplified by the demand for the combine's products; and the mining industry, together with other beneficiaries of the painstaking skill developed by the founders of the enterprise, has been instrumental in beating a path to the organization's door.

BAUXITE MINING IN



General view, Three Friends mine, British Guiana

BAUXITE was first definitely identified in British Guiana in the 'nineties by the late Sir John B. Harrison, formerly Director of the Department of Science and Agriculture of British Guiana. Previous to that the more accessible deposits had been seen and visited by several government geologists, but their significance was not really appreciated until the late 'nineties. A more general interest and search for bauxite in the colony began about 1910; and the government records indicate that the first concessions were applied for in 1913. Interest in the deposits increased with ensuing years. Although several companies from time to time have been interested in bauxite deposits in British Guiana, so far there has been only one producing company—the Demerara Bauxite Company, Ltd., formed in 1916. It is a British Guiana corporation, being a subsidiary of Aluminium, Ltd., of Toronto.

Shipments of bauxite began in 1917, the material being brought down the Demerara River in punts from the Three Friends mine to Mackenzie, where it was loaded into steamers lying in midstream. Prior to 1920 all the material shipped was crude bauxite as mined. In that year driers were installed to drive off the free moisture, in order to benefit by the considerable saving in ocean freight. In 1922, following exhaustive experiments, it was decided to install washers in British Guiana, which was done in 1923, and that year saw the beginning of the first shipments of crushed, washed, and dried Demerara bauxite.

Ocean-going steamers can ascend the Demerara River only as far as Mackenzie, which is about 10 miles from Three Friends mine and 64 miles south of Georgetown. The milling and ship-loading plant is at Mackenzie, and a 10-mile 36-in. gage railway, laid with 60-lb. rail, was built, connecting Three Friends mine with the milling plant. The alignment of the railroad follows high ground wherever possible; but so much of this part of the colony is low and swampy that of necessity a great part of the road had to be built across swamps at heavy cost. At first, white sand from some of the numerous sand hills in the vicinity was tried as ballast. However, the roadbed did not stand up under the continuous traffic of ore trains, and low-grade bauxite was substituted, with good results.

The Three Friends deposit is in the shape of a flat lens, dipping slightly toward the east. The bauxite averages about 18 in. thick. Overburden varies from zero near the edges of the deposit to a maximum of 60 ft. over the center, which is far too much overburden to be removed economically by steam shovels. The maximum economic depth which can be stripped in this manner, with the average thickness of bauxite mentioned above, appears to be between 18 and 25 ft. Plans are being studied for stripping hydraulically those parts of the orebody which lie under excessive overburden.

Where the overburden on a lateritic bauxite deposit is of considerable thickness, it is unusual to find the upper surface of the usable bauxite clean cut and well defined. For this reason, rather careful stripping is necessary at Three Friends, particularly as there is considerable hard clay and in places coarse sand and quartz in the overburden, both of which are not easy to remove from the bauxite in the mill. Model 18-B Bucyrus steam shovels with $\frac{3}{4}$-yd. buckets are used for stripping and mining. Where the surface of the bauxite is pockety and irregular, a certain amount of secondary stripping must be done by means of hand labor and mule carts.

This is the second of a series of articles on bauxite mining in northern South America, the first of which appeared in the issue of Aug. 17.

BRITISH GUIANA

By LAWRENCE LITCHFIELD, JR.
Geologist, Republic Mining & Manufacturing Company, Pittsburgh, Pa.

The ore is prepared for blasting by drilling 1¼-in. vertical holes by means of jumper drills. These holes are put down by hand labor; the bauxite being comparatively soft, it is cheaper to drill by this means than to use compressed air. The drills are made in three lengths of 12, 16, and 20 in. respectively. Two men are used on each drill. It has been found that one man can drill between 3 ft. and 5 ft. per hour, depending on the nature of the material. The holes are spaced 9 ft. apart and are sprung with about one pound of dynamite. After springing, the holes are blasted with charges of black powder and dynamite together in the proportion of about 50 lb. of the former to 2 or 3 lb. of the latter. The aim is to reduce to a minimum the proportion of large lumps, but, even so, considerable secondary blasting and blockholing is necessary. The number, spacing, and depth of holes are adapted to suit local variations in the character of the ore. An average of one-half pound of explosive is used per ton mined.

The bauxite is loaded into 4-yd. side-dump cars, either by hand or with steam shovel. In 1928, the ratio of hand-loaded ore to shovel ore was about 7 to 9. Eighteen-ton Porter dinkey locomotives take the mine cars to the assembling yard, where trains are made up for haulage to the mill. As many as 80 railroad cars are hauled to the mill at one time, the locomotives used being 30-ton and 35-ton Porters.

DETAIL OF MILLING EQUIPMENT

Milling and storage plant consist of the following:

1. Concrete trestle-approach to crusher and washer building, 576 ft. long.

2. Crusher and washer building 74x206 ft., of wood framing with concrete floor and galvanized-iron roofing and siding; all sides except the western side are open.

3. Conveyor bridge from washer building to drier building. Wooden trestle with corrugated-iron roofing and sides.

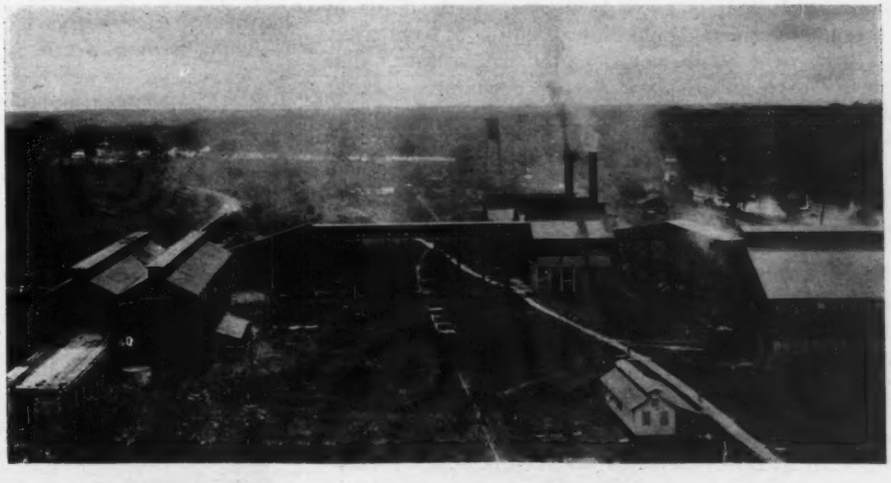
4. Drier building 72x186 ft., concrete floor, wood framing, galvanized corrugated-iron roofing and siding.

5. Conveyor bridge from drier building to storage building. Wooden trestle with galvanized corrugated-iron roofing and sides.

6. Bauxite storage building 94x140 ft., concrete floor and reinforcing walls, steel framing, corrugated galvanized-iron siding, and patented reinforced asbestos roofing.

Ore trains, on arrival at the plant, are taken directly onto the concrete trestle, where the cars are dumped into the unloading hopper. The ore is first screened in an 18-ft. x 50-in. trommel screen with 3-in. holes; while passing through this trommel it is sprayed with water. Undersize from the trommel screen goes directly to the collecting sump; oversize passes to a No. 8 Gates gyratory breaker, which discharges its product to the collecting sump. From here the mixture of ore and water is pumped by an 8-in. centrifugal volute pump to a distributing hopper over the washers.

There are four Dorr washing units, to which the ore is fed from the distributing hopper. Each washing unit consists of a trommel with ⅜-in. holes and a rake. The feed first passes through the trommels, where it is washed by a spray. Oversize from these trommels passes directly to a 36-in. belt conveyor, which takes it to the kiln building; undersize passes to the rakes, where it is further washed by agitating and raking against a

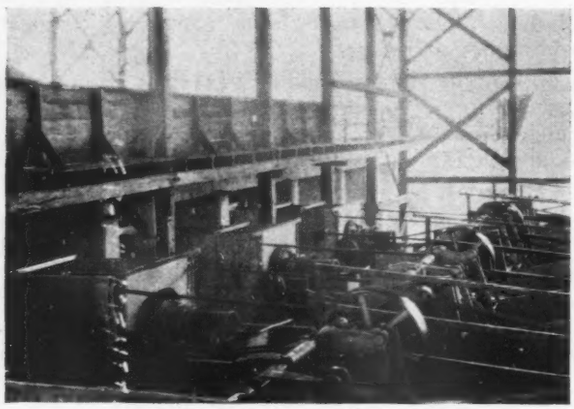


At Mackenzie, British Guiana. Unloading building at left, kiln building in center, storage building at right.

flow of water. From the rakes the fine washed material passes to the belt conveyor mentioned above, where it joins the oversize from the trommels and is taken to the wet-ore platform in the drier building.

The washing process removes most of the clay intermixed with the bauxite, reducing the percentage of total silica to slightly under 3 per cent. About 1,600 gal. of water is used per ton of green ore fed to the washers, which is the equivalent of about 2,300 gal. per dry ton. Of the total green ore fed to the washers, close to 70 per cent is recovered as dried ore. The remainder consists of free moisture in the green ore and intermixed clay, which is removed in the washers.

Overflow water from the washers containing in suspension the clay washed from the bauxite is passed to the tailing sump, from which it flows by gravity to the tailing pond. This washer overflow cannot be discharged directly into the river because of the danger of silting up at certain points and forming bars and shallows. For this reason a tailing pond has been constructed back from the river by impounding a considerable area by means of low dikes. This gives the sediment in the overflow water a chance to settle out, so that the outflow from the tailing pond itself is clear water and causes no muddiness in the Demerara River or tributary creeks.



Dorr washers at the Mackenzie plant

From the wet-ore platform in the drier building the ore is charged into two 8x100-ft. rotary kilns. Free moisture is reduced to about 1.5 per cent in the drying process. The kilns are fired by pulverized coal. Washed Alabama slack coal is used, being fed to the kilns by two Aero pulverizers. The consumption of coal averages a little over 80 lb. per ton of dried bauxite. The capacity of each kiln is about 22 tons an hour.

From the kilns the hot ore is discharged onto a 30x30-in. Peck carrier, which allows the material to cool before being taken to storage. A 36-in. cast-iron pan conveyor takes the ore from the Peck carrier and discharges it onto a 24-in. belt conveyor which runs along the top of the storage building. An automatic trip on this belt distributes the bauxite in the building. A conveyor tunnel is built on the floor of the storage building, which houses the 42-in. boat-loading conveyor. Discharge chutes spaced along this tunnel discharge the ore onto the boat-loading conveyor, which is carried out over the dock and over the holds of the vessel by a trestle and movable boom as shown in the illustrations. About 2,500 tons of bauxite can be loaded in eight hours. Sixty-nine vessels were loaded in 1928. The bauxite vessels tie up at an 800-ft. dock built largely of greenheart, a local timber that is especially suitable for underwater construction.

Steam is generated in six 160-hp. fire-tube boilers built by the B. Keeler Company. The fuel used is Alabama steam coal or local firewood, or both. Wood being cheaper, its use is limited only by its availability. The main power plant has three turbo generators as follows:

A 300-kw. alternator coupled to a 440-hp. Kerr turbine, designed to run at 3,600 r.p.m.

A 500-kw. alternator coupled to a 725-hp. Kerr turbine, also designed to run at 3,600 r.p.m.

A 750-kw. alternator coupled to a 750-kw. International General Electric turbine.

A well-equipped laboratory in charge of an experienced chemist is maintained. Very close control must be kept on all the operations from the time an orebody is first explored by Empire drill holes to the time when the washed and dried bauxite is passed into the hold of the vessel. Daily averages of the analysis of the crude ore fed to the mill, the washed ore from the trommels and rakes, the dried ore going to storage, and the solids going to the tailing pond are computed. A large number of samples are taken from the boat-loading conveyor during the loading of a vessel, so that an accurate analysis of each cargo is obtained. In addition to the ore analyses, the laboratory does a considerable amount of analytical work on the various materials used at the plant, such as coal, oil, pigments, and water.

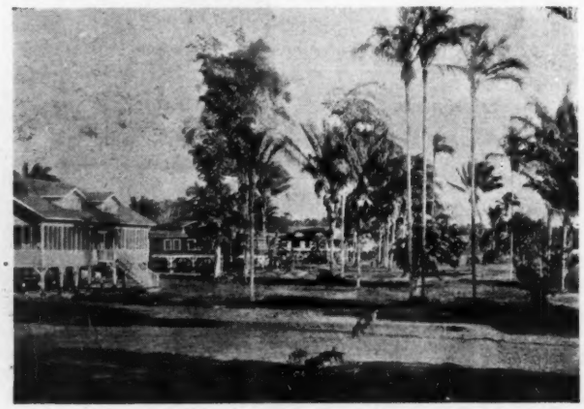
The total number of men on the payroll, counting the mine, railroad, mill, and miscellaneous departments, averages about 800. Most of the men are local Demerara natives. A few East Indian coolies are employed. Natives are used even for the skilled positions such as shovel drivers, locomotive drivers, electricians, and mechanics. It takes about one month to train a locomotive driver and a little longer to prepare steam-shovel operators. Some of the latter compare very favorably as to shovel output with the average shovel operator in the United States.

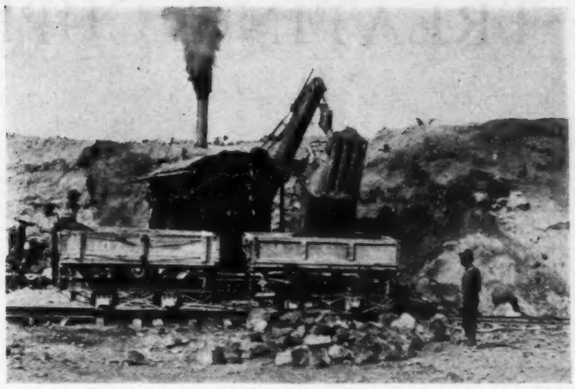
Water for the plant and for domestic purposes, except cooking and drinking, is pumped from the river and is stored in two large elevated tanks. For drinking and cooking purposes rain water is used.

From the standpoint of sanitation, the principal problems are sewage disposal and mosquito control. The plant and villages are well drained and underbrush and rubbish are eliminated. Staff houses, hospital, and clubhouse are screened.

From the standpoint of labor efficiency, the most harmful disease with which the medical authorities have to cope is hookworm. The percentage of infection

Staff bungalows, Mackenzie, British Guiana





Loading bauxite at the Three Friends mine

among the native laborers is extremely high. Filaria is also rather common among the natives.

An excellent new hospital, housing 80 patients, was completed in the summer of 1925. The walls and floor are reinforced concrete, and asbestos shingles are used for the roof. The operating theater, sterilizing room, and maternity ward have tile floors and walls. This hospital has a splendid reputation throughout the colony, and a considerable proportion of the patients are non-employees coming from various parts of the colony for treatment in the company hospital. It is not at all unusual to find at the end of the month that more outside patients have been treated than company employees.

The manager and staff are quartered in attractive frame bungalows, with wood or asbestos shingle roofs grouped together in Watooka Village, about one-half mile south of the plant. A commodious clubhouse with mess hall, reading room and billiard room is operated by the company. Two concrete tennis courts are available to the staff. Laborers are quartered at Cockatara Village, about a quarter of a mile north of the plant. The bachelors live in barracks, bunkhouses, and five-room ranges (holding about 50 men each). Small individual houses are furnished the married men. A fine recreation hall, with main hall, billiard room, and reading room, has been constructed for the workmen, where smokers and moving picture performances are held periodically. In addition, football and cricket grounds are available, where games between local athletic clubs and between the latter and outside teams are frequently held. A school is also maintained for the children of the workmen.

The company operates a farm, dairy, ice plant, and ration store, the products from which are available to the staff and to the laborers as well.

Effect of Temperature on Copper Ore Leaching Is Studied

UNLIKE some other sections of the country, the Southwest regions of the United States do not become so cold in winter as to shut down leaching operations; copper hydrometallurgists in the Southwest carry on their work throughout the entire year, and thus encounter temperatures varying from nearly freezing in winter to as high as 150 deg. F. (direct sunlight temperature) in summer. Because of the fact that heap leaching is done in the open, the operation is subject to all temperature changes.

Whereas oxidized copper minerals dissolve very rapidly in the ordinary leaching reagents, sulphide copper minerals are attacked much more slowly, and ferric sulphate is the only commercial leaching reagent used. The U. S. Bureau of Mines, in co-operation with the University of Arizona, has studied the effect of temperature on the dissolution of sulphide copper minerals in ferric sulphate solutions. It has been found that whereas 49, 59, 67, 90, and 97 per cent of the total copper in chalcocite is soluble in 1, 2, 3, 8, and 20 days, respectively, at 35 deg. C., only 46, 50, 62, 65, and 80 per cent is soluble in the same time intervals, respectively, at 23 deg. C. With bornite the percentage extractions were 29, 34, 38, 56, and 68 at 23 deg. C., and 40, 54, 62, 90, and 98 at 35 deg. C. for the same time intervals, respectively, as listed under chalcocite.

Quebec Output Gives New Gold Record for Canada in 1928

CANADA'S gold production in 1928 again established a new high record, with a total of 1,890,592 oz., which, valued at the standard rate of $20.671834 per ounce, was worth $39,082,005, as against the 1927 production of 1,852,785 oz., worth $38,500,464, according to finally revised figures compiled by the Dominion Bureau of Statistics at Ottawa.

Production from Nova Scotia mines at 1,290 oz. was less than half that produced in 1927. The Quebec output of 60,006 oz. was much greater than in any previous year, owing largely to the continuous operation of the Noranda smelter, where gold recoveries from copper ores treated during 1927 averaged $3.82 per ton.

Ontario produced 1,578,434 oz., compared with the 1927 output of 1,627,050 oz. Production from the Porcupine camp was lower than in the previous year, but this decrease was nearly offset by the 26 per cent increase in the output from the Kirkland Lake area. Some gold also was recovered from the nickel-copper ores of the Sudbury area. Manitoba produced 19,813 oz., a considerable increase over 1927.

British Columbia's output, at 196,617 oz., was 7 per cent greater than in the previous year. Alluvial gold production was slightly less than in 1927. Yukon production amounted to 34,364 oz., comprising 34,116 oz. in alluvial and 248 oz. in silver-lead ores exported.

THE PROBLEM OF TREATING CUPRIF

An exhaustive research into methods and practice, with a survey of the available literature, by an experienced technician of Ottawa, Canada; a suggestive contribution to a subject of considerable importance to the gold-mining industry, in which the author maintains that no economical method has been evolved to date for the regeneration of cyanide from cupriferous cyanide-plant precipitate, and that the problem is one that should be considered as peculiar to each individual ore, demanding specific research and experimentation. A résumé of the more important points in the patent situation should be of considerable help to those in a position to continue the work.

CYANIDATION of gold-silver ores carrying appreciable amounts of copper usually leads to heavy consumption of cyanide. Where the copper minerals are oxidized, the consumption is much higher than for sulphide minerals of copper. Butters and Clennell[1] in 1892 noted that copper pyrite would probably be a source of trouble in future work. Argall[2] concludes that copper ores are unsuited to cyanide treatment. Julian & Smart[3] state that "The presence of copper is not necessarily a bar to the treatment of an ore by cyanide." The fortuitous mineral associations which will inhibit cyanide consumption seem to be of infrequent occurrence in copper-bearing gold ores. Forbes[4] found cyanide consumption high and extraction low in treating tailing from sulphide ore that contained a high percentage of copper. Dixon[5] found that any form of copper tended to precipitate gold and silver from cyanide solutions.

Various writers state that the solution of copper results in the production of complex cyanides — $K_2Cu_2(CN)_4$, $K(CuCNS)(CN)_2$, and copper ferrocyanides held in solution by excess cyanide. Thorpe[6] states that about 2½ mols of KCN are needed per mol of $Cu_2(CN)_2$ for solution. Solution of copper takes place by reason of the fact that the CuCN ion formed gives an extremely low concentration of copper ion. The particular ion formed seems to be in doubt. Thorpe gives $Cu(CN)_2$ and $Cu(CN)_4$, whereas Treadwell and Van Girsewald give $Cu_2(CN)_2$. It is clear that reference to an ionic condition only is necessary, and for that purpose reference to CuCN is satisfactory.

Ferguson and Sturtevant[7] state that the copper-ion concentration in an alkaline cyanide solution is about 10^{-28} normal. So low a concentration makes it very doubtful that copper exists in such solutions in any other combinations than CuCN ions. Direct removal of copper from cyanide leach solutions is therefore rendered difficult. Morgan[8] found that in a 0.05 molar solution of $KAg(CN)_2$ the silver was ionized to the extent of 3.5×10^{-11} and the CN^- to 2.76×10^{-3} mols per liter. Frary[9] gives the concentration of silver ion in N/4 $KAg(CN)_2$ as 8×10^{-12}. With free cyanide present in the same solution to the extent of N/40, the silver-ion concentration was 4×10^{-18}. Silver should therefore be much more easily stripped from solution by electrolysis or precipitants than can copper.

Thorpe[6] states that cyanide solutions of copper contain the complex anions $Cu(CN)_2^-$ and $Cu(CN)_4^=$, which are so little dissociated into copper ions that hydrogen sulphide will not produce a precipitate in the solutions, and that, therefore, copper itself and all of its compounds in the presence of oxygen dissolve readily in cyanide solutions. Zinc cyanogen ions are less stable than those of copper, gold, silver, and mercury, and a small excess of alkali sulphide precipitates the zinc. $K_2Cu_2(CN)_2$ does not dissolve gold. But Sharwood[10] found that $K_2Zn(CN)_4$ dissolved gold, but not as readily as does KCN.

In the usual precipitation of gold and silver with zinc dust, only a part of the copper appears to precipitate. The potential of the copper in a dilute cyanide solution lies close to that of zinc, with the copper more noble than the zinc. In the more concentrated solutions, however, the direction of the couple is reversed, and the zinc is actually more noble than the copper (Spitzer[11], Allmand and Ellingham[12]).

The potential of the zinc-copper couple is quite low in any leach solution, but prolonged treatment with zinc impregnated with lead may perhaps give precipitation of the copper. W. N. Virgoe[13] states that, at Minas Prietas, Mexico, the solution from the zinc launders, containing three to four pounds of copper per ton, was run over zinc shavings which had been steeped in lead acetate solution, by which the copper was reduced to 1.25 lb. per ton. The precipitate ran $2 gold per ton and 25 per cent copper. Barker[14] states that the lead-zinc couple will not precipitate effectively the copper from cyanide solution. He recommends acidification for removal of the copper, and regeneration of the liberated cyanide by the addition of alkali.

Electrolysis of the leach liquors may give incomplete removal of the copper, although very low current densities would have to be employed. The efficiencies may be expected to be low, as in electrolytic precipitation of gold and silver. Christy[15] gives current efficiencies as follows for gold and silver: Siemens & Halske process, 0.6, 0.3, and 2.03 per cent; Butters process, 5.05 to 12.9 per cent. He also says that electrolysis of cyanide solutions destroys the cyanide. After removal of the silver from the solution, further electrolysis destroys the cyanide. Hamilton obtained current efficiencies of 4.83 6.10, 13, 13.24, and 13.9 per cent (Christy[15], *loc.cit.*).

Copper precipitation by electrolysis would require a large installation of cells, larger than for precipitation of gold and silver. Clevenger[16] states that, at the Butters' Virginia City plant, in Nevada, 65 per cent of the gold and silver, 20 per cent of the copper, and a small amount of the zinc were precipitated by electrolysis, with a gain of 0.075 per cent in cyanide strength. The solution to electrolysis ran 0.15 per cent simple cyanide and 0.38 per cent total cyanide. The same writer gives results at the Butters' Minas Prietas plant, in Mexico. The gain in cyanide by electrolysis amounted to 0.0146 per cent, or 0.35 lb. per ton ore in one instance, and 0.0118 per cent, or 0.94 lb. KCN per ton slime, in the other. Regeneration was greater with ores carrying copper and was negligible with ores containing no copper. Christy[15] says that "while regeneration of cyanide is possible from rich silver solutions, it is not usually possible with such gold solutions as occur in practice." A steady loss of cyanide occurs with such solutions nearly proportional to the time. Clevenger says[17] that, "On the whole, electrolytic precipitation, used either alone or in combination with a chemical precipitant, would prove advantageous where there was a considerable bulk of metal to precipitate and where there was a decided tendency for the formation of sulphocyanide (which is regenerated?). With ores containing much copper it is a necessity." Clennell[18], however, obtained erratic regeneration results in electrolysis of working solutions containing sulphocyanides, using lime to secure alkalinity.

Richmond[19] gives results of electrolytic precipitation at San Sebastian, San

...EROUS PRECIOUS-METAL ORES BY THE CYANIDE PROCESS

By A. C. HALFERDAHL

Salvador. Copper, antimony, pyrite, marcasite, tellurium, and arsenic occur in the ore; 1.5 to 2.5 lb. copper per ton is recovered in precipitation. The pregnant solutions are precipitated at one ampere per square foot of anode surface at 40 to 45 volts. The solution then goes to zinc boxes. Tailing solutions from the zinc boxes are still high in copper. The electrical boxes regenerate from 3.9 to 65 per cent of the cyanide. His tabulation indicates that the amount of regeneration is roughly equivalent to the amount of copper precipitated.

Rose[20] found, in the electrolytic regeneration of cyanide, that the principal difficulty was in finding an anode of high conductivity that would not dissolve or disintegrate. The solutions treated were zinc precipitation filtrates, containing a little copper, and the metal deposited was 71 per cent zinc. The percentage of regeneration is not given. Cyanide is regenerated at the cathode and is destroyed at the anode; but this destruction, it is stated, may be overcome by maintaining a high protective alkalinity. A porous diaphragm separating anode and cathode assists in maintaining proper alkalinity of anolyte.

Kern[21] found that electrolytic precipitation consumed more cyanide per ton of ore than unelectrolyzed solutions. A low current density leads to less destruction of cyanide than does a higher one.

Clevenger and Hall[22] showed that electrolysis of cyanide solutions produced cyanate, with destruction of cyanide.

Rice[23] gives results on cyaniding copper-bearing tailing. The solutions were electrolyzed in Siemens-Halske boxes. The precipitate contained 30 per cent copper. Solutions to electrolysis ran 0.05 per cent KCN; those from electrolysis, 0.09 per cent KCN.

Rose[24] performed experiments in electrolytic precipitation of gold from cyanide solutions on amalgamated copper plates. A low current density was essential and efficiency was low. Destruction of cyanide took place at all current densities. Von Gernet[25] found amalgamated copper plates unsatisfactory as cathodes. Molloy's process[3] employs a sodium amalgam made by electrolysis for the precipitation of metallic cyanide solutions. Hussey[26] has a similar proposal, using sodium bromide. More recently Duschak[27] has suggested a somewhat similar method.

Davis[23] attempted electrolysis of double cyanides by direct current, but he destroyed the cyanide. He found that an alternating current (60 cycles at 0.05 to 0.10 amperes per square foot) would raise the free-cyanide content, with precipitation of the base metals when an excess of free alkali was present. This scheme was tried at the Smuggler Union mill, and, it is stated, saved 25 per cent of the cyanide consumed normally.

Summary of Conclusions

1. Electrolysis of original-ore cyanide solutions has not been successful in precipitating the copper and regenerating the cyanide.

2. Ammonium-cyanide treatments have not gone beyond the laboratory stage.

3. Regeneration by acidification of residual plant solution, originally proposed by MacArthur, will recover about 50 per cent of the bound cyanide, depending on the character of the original ore. A combination process is suggested as offering promise.

4. Treatment of sludge precipitate involves consideration of its chemical character. The proposals of Wright, Kirsebom, Leaver & Wolff, and du Bois are deserving of study in this connection.

Aldrich[29] used alternating and direct currents to regenerate cyanide, or to prevent its destruction and to hasten dissolution of the metal. This scheme seems to have failed at the Liberty Bell mine (Chase[28]). Kitsee[31] has a similar proposal.

Orr[32] proposes use of zinc-ore anodes in cyanide solution, especially when it contains copper. He regenerates cyanide by throwing down zinc with caustic potash and sodium sulphide. Cyanide is recovered from residual solutions by treating with an excess of zinc chloride, to precipitate the cyanide, which is returned to the working solution as desired. It is not clear to me that zinc would not be precipitated, together with copper, gold, and silver, at the cathode.

Pfleger's process[33], which was used by Julian[3], contemplated a short-circuited diaphragm cell, the anolyte being a caustic solution with zinc bars, and the catholyte the metallic cyanide solution with iron-gauze cathodes.

Electrolytic deposition of copper and zinc is hindered by the presence of KCN, the metal separation being limited to equivalent oxidation of cyanide at the anode, in strong solutions. The best condition for anodic decomposition of KCN is low alkalinity (0.2N). Allmand and Ellingham[12] say that the current density-potential curves for copper deposition and hydrogen evolution lie close together. O. P. Watts and A. Brann[34] give single electrode potentials of silver and copper in cyanide solutions as shown below.

The discharge potential of hydrogen "was taken as the lowest potential at which gas escaped steadily from the cathode." Silver should be much more easily stripped from solutions than copper. Increase in free cyanide concentration, desired in the precipitation of copper, would only increase the difficulty of further stripping. Very low current densities must be use if a cyanide solution is to be stripped of copper by electrolysis, or hydrogen evolution will occur. Lay[35] emphasizes the necessity of low current densities. Where the solution contains only KCN enough to give $KCu(CN)_2$, copper may be deposited reversibly. Conditions affecting the deposition of gold from cyanide solutions seem to be similar to those for silver. Withrow[36] deposited gold completely from strong cyanide solution at high current densities, and rapidly. Tainton[37] used rotating cathodes in a diaphragm cell for gold solutions.

The best conditions for removal of copper from cyanide leach solutions by electrolysis apparently comprise (1)

Concentration of KCN added	N/100	N/10	N/2	N/1
Silver:				
Single potential	0.04	0.18	0.28	0.31
Discharge potential of H	0.59	0.56	0.62	0.55
Difference	0.55	0.38	0.34	0.14
Copper:				
Single potential	0.53	0.67	0.78	0.82
Discharge potential of H	0.67	0.70	....	....
Difference	0.14	0.03	....	....

Use of a diaphragm cell; (2) very low current density; (3) comparatively high alkalinity in anolyte; (4) rapid circulation or agitation of the catholyte in order to supply the cathode with $(CuCN)^-$ ions for reduction; (5) low concentration of free cyanide, the lower the better.

High alkalinity of the catholyte may raise the hydrogen potential sufficiently to give ammonia from the cyanide (Clevenger and Hall[32], *loc. cit.*). High alkalinity of the anolyte, however, will hinder, if not prevent, regeneration of cyanide from thiocyanides.

Jarman and Brereton[38] give results of experiments on an ammonia cyanide leaching process. Loss of cyanide as NH_4CN took place. It is stated that lime precipitates copper from dilute commercial solutions (0.1 to 0.2 per cent NH_3) in the cold. Copper is removed as a dark-brown precipitate. Lime precipitation of copper commences at about 71 deg. C., and is complete at 85 deg. C. if the time taken between these temperatures is from 15 min. with weak solutions to 45 min. with 3 or 4 per cent of ammonia present. MacArthur, in the discussion following, said that the process was not commercial. Clennell[39] gives the composition of one such precipitate as $4NH_4Cu(CN)_2.2Cu_2(CN)_2$.

The Mosher-Ludlow process contemplates leaching with ammonia and cyanide[40].

Burr[41] suggests introduction of ammonium chloride into cyanide solutions in proportions to yield 1 per cent of free ammonia for each 1 per cent of copper present. Enough lime is added to liberate the ammonia. The copper will then form a couple with the gold or the silver or both, it is said. The copper may be precipitated electrolytically or by simply raising the temperature of the pregnant solutions before zinc precipitation. Evolved ammonia and possibly the ammonium cyanide are collected and used again in the process. The details of an experiment which attempted to follow the conditions set forth above are recorded later.

Spearman[42] suggests that filming of chalcopyrite in an analogous way to the filming of graphite in ores with oil may overcome its destructive effect on cyanide. Cathcart and Ryan[43], however, obtained negative results on a chalcopyrite ore.

The greatest progress in treating foul cyanide solutions was made by acidifying the solutions and precipitating the copper and silver (Gahl[44]). Most of the gold is also precipitated. The hydrocyanic acid so generated is changed back to salt by absorption in alkali. Acidification is accomplished with sulphur dioxide or with sulphuric acid. Several experimenters and inventors have had this idea in view. De Wilde[45] precipitated cupro-auro cyanide, using copper sulphate and sulphur dioxide, and contemplated recovery of the liberated hydrocyanic acid by treatment with alkali. He says it is possible, though not practicable, to recover part of the cyanogen from the dry precipitate, by passing hydrogen sulphide over it and producing hydrogen cyanide. Excess of hydrogen sulphide is absorbed by passing the gases over lead sulphate, and the hydrogen cyanide is absorbed in alkali. For Barker's proposal, see earlier discussion in this paper. Caldecott and Johnson[46] state that copper sulphate reduced by SO_2 from the acidulated solution precipitates gold as double aurous-cuprous cyanide, $Au_2Cu_2(CN)_4$.

Porter[47] subjects ore to the usual action of cyanide, dissolving gold, silver, copper, and other metals. Gold and silver are precipitated in the ordinary way on zinc shavings, and the resulting solution is treated with acid, giving copper cyanide precipitate and hydrocyanic acid. The hydrocyanic acid is neutralized with alkalies, producing an alkaline cyanide suitable for a repetition of the process. The cyanide of copper is mixed with an alkaline solution and the mixture treated by electrolysis, depositing copper and regenerating alkaline cyanide solution.

Anderson and Scanlon[48] proposed to recover precious metals from cyanide solutions by adding soluble chlorides and sulphides and then a mineral acid, such as sulphuric acid. The insoluble metal compounds formed are separated, and the cyanide is regenerated by the addition of lime.

Wright proposed the following treatment[49]: The pulp is first treated with cyanide, and the extracted metals are precipitated with sulphuric acid. The acid is then neutralized with lime, thus regenerating the cyanide, which is used for a second treatment of the pulp, in order to dissolve the remainder of the precious metals.

In 1908 Wheelock[50] rediscovered Anderson's process. Von Bernewitz[51] gives Williamson's[52] method of treatment of the precipitates, which is taken to be cuprous cyanide, $Cu_2(CN)_2$. This is suspended in water and treated with H_2S according to the equation:

$$Cu_2(CN)_2 + H_2S = Cu_2S + 2HCN$$

This process was never used on a working scale, but laboratory experiments gave as high as 90 per cent regeneration of the combined cyanogen.

Kirsebom[53] suggests that the silver in pregnant solutions be precipitated with sodium sulphide, followed by acidification with SO_2 and addition of further sodium sulphide to precipitate gold and copper—the copper as sulphide. After filtration, the solution is made alkaline with lime. Thiocyanides usually are present in mill solutions. On acidification, if copper is present, copper thiocyanide precipitates.

Layng[54] treats copper thiocyanide (CuCNS) with nitric acid, or with a nitrate and sulphuric acid. The scheme is to treat the solution from the ore with acid to precipitate sulphocyanides, or thiocyanide:

$$Cu_2(CNS)_2.6KCN + 3\,H_2SO_4 = Cu_2(CNS)_2 + 6HCN + 3K_2SO_4.$$

If the metal is not all in solution as sulphocyanide, but as a simple cyanide dissolved in alkaline cyanide, the acidification will precipitate sulphocyanide, thus:

$$KAg(CN)_2 + KCNS + H_2SO_4 = AgCNS + 2HCN + K_2SO_4$$

Free sulphocyanide in the solution can be precipitated with cuprous chloride. The precipitates are treated in a retort with an oxidizing agent such as nitric acid or sodium nitrate in the presence of sulphuric acid, oxidizing the sulphur and forming hydrocyanic acid:

$$KCNS + 2\,NaNO_3 + 2H_2SO_4 = 2NaHSO_4 + KHSO_4 + HCN + 2NO$$

The hydrogen cyanide is absorbed in alkali and the NO is oxidized to nitric acid. The residue contains copper sulphate, which with sulphur dioxide may be used to precipitate sulphocyanide from acidified cyanide solutions. Layng[54] is of the opinion that CuCNS exists in solution as $Cu_2(CNS)_2.6KCN$, and that acidification liberates 75 per cent of the bound cyanide. Although 75 per cent of such cyanide may be liberated, the data do not prove the existence of this compound. The foregoing reactions by Layng do not envisage oxidation of cuprous copper to cupric copper.

Raschen, Norman, and Luxton, and United Alkali[55] treat sulphocyanides with nitric acid or with a mixture of sulphuric acid and sodium nitrate, in a decomposing vessel, to obtain nitric acid. This process was used by United Alkali[56] for the commercial production of cyanide.

Noerdlinger and Noerdlinger[57] propose to treat waste waters or very dilute solutions containing thiocyanogen or cyanogen compounds with acid such as sulphuric acid (not nitric acid). If thiocyanides are present, an oxidizer, such as manganese dioxide, is added. Then air is blown through the solution, and the hydrogen cyanide evolved is condensed in alkaline or other solutions. The liquid may be heated.

Layng[58] has a similar proposal. Ore is treated with cyanide solution, filtered, and the solution conveyed to a sealed vessel, where a reagent, to liberate hydrogen cyanide and to precipitate salts of metals, is added. A gas is passed through the liquid to carry off the hydrogen cyanide, which is recovered by bringing it into contact with zinc hydroxide, and boiling the resulting zinc cyanide with water. The precipitated salts of metals are filtered off.

Noerdlinger[59] removes cyanides and sulphocyanides from water by acidulating and passing a current of hot air through it, in order to drive off the cyanide compounds present.

Wright[60] precipitated copper from cyanide solutions with sulphuric acid. He attempted to regenerate the cyanide in the precipitate with sodium sulphide

in the primary acidification circuit as follows:

$$Cu_2(CN)_2.2KCN + Na_2S + H_2SO_4 = Cu_2S + 4HCN + Na_2SO_4 + K_2SO_4$$

The reaction was incomplete. The precipitate was heated, also electrolyzed, but the results were not successful. A 51.9 per cent regeneration of cyanide was obtained by neutralizing the liberated hydrogen cyanide with lime.

More recently Halvorsen[61] has developed a process for de-cyaniding waste solutions. The solutions are acidified with sulphuric acid or with sulphurous acid, and are then distilled with live steam as an auxiliary denuding agent under vacuum, for recovery of hydrogen cyanide, which is absorbed in lime solution.

The first work on regeneration of cyanide solutions appears to have been done by MacArthur[62]. The solutions were neutralized with acid and enough acid was added to decompose all of the single, all of the double, and half of the compound cyanides present. Then the solution was suitably heated, and the evolved hydrogen cyanide was absorbed by caustic alkali solutions. The residual cyanides in the sludge were treated with caustic soda or milk of lime, to bring the cyanide into solution, which was treated as described before, after removing insoluble material, or evaporated and crystallized. Similarly, de Las Fuentes[63] regenerates cyanide by decomposing the solution by an acid, and recovers the HCN vapor by diminishing the pressure or by raising the temperature, or by both means, and passes the vapors through an alkaline solution.

Gold is precipitated from cyanide solutions by mercuric chloride, copper, and cupric sulphide in the presence of sulphuric acid (Christy[64]). Filtration through cupric sulphide may be sufficient to precipitate the gold. If HCN is absent, gold is precipitated by copper, atom for atom. By the use of Haut's process, patented in 1895, the cyanide is recovered from strong solutions (1 per cent) before precipitating the gold by the cuprous method. Soluble sulphides are removed by lead sulphate first. Zinc sulphate is then added in excess, and the resulting zinc cyanide is removed. The zinc cyanide is decomposed by sulphuric acid, and the hydrogen cyanide is absorbed in caustic potash. The gold does not precipitate with the zinc cyanide, but is in solution as $HAu(CN)_2$, which is precipitated with copper sulphate plus sulphur dioxide. If ferrocyanides are present, acidulating the original solution with direct absorption of hydrogen cyanide is superior to precipitation with zinc sulphate (Christy).

Crook, Booth, and Thiel[65] electrolyzed solutions of potassium sulphocyanide, thus:

$$KCNS + 2NaOH + 3O = KCN + Na_2SO_4 + H_2O$$

They found that absence of, or too much, alkalinity gave no formation of cyanide. I found, however, that acidity was favorable to formation of cyanide, HCN. Alkalinities of 0.4 per cent or less were favorable to the above reaction. Graphite electrodes were used. Evidently there is a critical oxygen potential for this anodic oxidation which is lowered by more alkali (see Clennell[29]).

Parker and Robinson[67] precipitate the solution containing thiocyanide by copper sulphate and a suitable reducing agent such as iron sulphate or sulphur dioxide, similar to Layng. The precipitate of copper thiocyanide is treated moist with carbon dioxide or hydrogen sulphide under pressure, and the resulting sulphocyanic acid is separated from the copper salt by filtration. The filtrate is electrolyzed at 10 to 30 amperes per square foot, and the liberated hydrogen cyanide is condensed in water or an alkaline solution to form cyanide.

DuBois[68] proposes to pass free CNSH, a water solution of $CNSNH_4$, or similar compound, in a finely divided condition, through a gas containing oxygen, at a temperature of from 380 to 750 deg. C., preferably from 500 to 600 deg. C. The HCNS is said to be converted to HCN by this procedure.

Considerable confusion exists as to the particular compounds of copper formed in the cyanide solution. Clennell[29] gives a reaction for copper sulphide thus:

$$2Cu_2S + 4KCN + 2H_2O + O_2 = Cu_2(CNS)_2 + Cu_2(CN)_2 + 4KOH$$

The insoluble cuprous thiocyanide and cyanide dissolve in an excess of KCN. Inasmuch as the solutions almost invariably contain an excess of alkali thiocyanide, the further reaction is probably as follows, according to Clennell:

$$Cu_2(CN)_2.6KCN + 4KCNS + H_2O + O = 2Cu_2(CNS)_2 + 8KCN + 2KOH$$

The reaction for carbonate of copper is stated to be:

$$CuCO_3 + 2KCN = Cu(CN)_2 + K_2CO_3$$

and

$$2Cu(CN)_2 + 4KCN = Cu_2(CN)_2.4KCN + (CN)_2$$

When sufficient alkali is present it is:

$$(CN)_2 + 2KOH = KCN + KCNO + H_2O$$

To study the loss of cyanide, six 1-lb. lots of a gold-copper ore were treated with cyanide, lime and lead acetate. The acidity of the ore was 2.2 lb. CaO per ton. The first four lots were treated with 5-lb. lime per ton, and the last two lots were treated with 12 lb. lime per ton; ¼ lb. lead acetate per ton was added to all of the tests. In all tests the original volume of solution used was 1,300 cc.

Leaching Results

Experiment No.	Dry Weight of Ore, Grams	Initial Volume of Solution cc.	Initial Strength, % KCN	Lime, Pounds per Ton Ore	Volume of Leach Including Washes, cc.
1	454	1,300	0.05	5	1,410
2	454	1,300	0.10	5	1,410
3	454	1,300	0.15	5	1,410
4	454	1,300	0.20	5	1,370
5	454	1,300	0.15	12	1,585
6	454	1,300	0.20	12	1,620

Experiment No.	Cyanide Consumption, Pounds KCN per Ton Ore	Total Sulphur in Leach, %	CNS in Leach, %	Proportion of Sulphur as CNS
1	2.38	0.0122	0.0094	42.6
2	4.86	0.0200	0.0213	58.9
3	7.21	0.0240	0.0315	72.6
4	7.25	0.0195	0.0275	77.9
5	7.48	0.0269	0.0435	89.2
6	10.60	0.0196	0.0335	94.4

Experiment No.	Copper Dissolved per Ton Ore, Pounds	(a) Copper Contained in Precipitate, Grams	CuCNS in Precipitate, Grams
1	0.42	0.03340	0.05412
2	1.15	0.09256	0.1541
3	1.45	0.1163	0.2061
4	1.16	0.09536	0.1417
5	1.54	0.1065	0.1664
6	1.58	0.1073	0.1625

Experiment No.	Copper Corresponding to CuCNS, Grams	Weight in Precipitate of Cu as CuCNS, %	$Fe(CN)_6$ in Precipitate, Grams	Copper in Filtrate, Grams
1	0.0283	84.8	0.0075	Nil.
2	0.0805	87.0	0.0075	0.0004
3	0.1078	96.6	0.0075	Trace
4	0.0741	77.8	0.0180	0.0008
5	0.0869	81.6	0.0054	0.0039
6	0.0585	80.0	0.0048	0.0052

Experiment No.	$Fe(CN)_6$ Filtrate, Grams	CNS in Filtrate, Grams	Total CNS %, in Filtrate	Total CNS %, in Precipitate	Gold Extracted, %
1	0.0075	....	....	....	12.0
2	0.0075	....	....	....	64.9
3	0.0180	....	....	....	95.9
4	0.0180	....	....	....	83.2
5	0.0102	0.1096	50.4(b)	40.0	96.6
6	0.0098	0.0516	53.9(b)	32.8	98.5

(a) 500 cc. of each leach was acidified with dilute sulphuric acid, and the precipitate filtered and washed after standing 24 hours. The precipitate was well washed, but may have contained a small amount of calcium sulphate. If sulphur dioxide is used, precipitate would probably contain some calcium sulphite.

(b) Probably low, because HCNS decomposes in acid solution on standing:

$$2HCNS + 2H_2O + H_2SO_4 = (NH_4)_2SO_4 + COS,$$

and COS is volatile.

The ore assayed: Au, oz. per ton, 1.04; Cu, per cent, 2.59; Fe, per cent, 12.0; S, per cent, 2.90; insoluble, per cent, 50.4. The ore was ground dry to pass 150 mesh. Treatment was by agitation for 22 hours. The leaching results are to be found in the table at the bottom of the preceding page.

The cyanicides are copper and sulphur.

The cyanide consumed as thiocyanide is indicated to be 4.4 lb. per ton ore as an average in Tests 5 and 6. Average indicated cyanide (KCN) consumption in these two tests is 9.0 lb. per ton, or 50 per cent goes to thiocyanide. Regeneration by acidification without treatment to recover cyanide from thiocyanide would not recover more than 50 per cent of the cyanide. Preliminary removal of the sulphides by flotation should decrease cyanide consumption. Reasonable experimentation would be in the direction of decreasing the time of contact of the solutions in order to cut cyanide consumption. Insufficient copper was present to precipitate all of the thiocyanide.

Burk and Pettis discuss[61] precipitation reactions, using SO_2 gas and water, and give reactions as follows:

$$Ca(OH)_2 + SO_2 + H_2O = CaSO_3 + 2H_2O$$

$$2NaCN + SO_2 + H_2O = Na_2SO_3 + 2HCN$$

$$Ca(CN)_2 + SO_2 + H_2O = CaSO_3 + 2HCN$$

$$Na_2Zn(CN)_4 + 2SO_2 + 2H_2O = ZnSO_3 + Na_2SO_3 + 4HCN$$

$$NaAg(CN)_2 + NaCNS + SO_2 + H_2O = AgCNS + Na_2SO_3 + 2HCN$$

$$Na_2Cu_2(CN)_4 + 2NaCNS + 2SO_2 + H_2O = Cu_2(CNS)_2 + 2Na_2SO_3 + 4HCN$$

Absorption reactions are:

$$2HCN + Ca(OH)_2 = Ca(CN)_2 + 2H_2O$$

$$SO_2 + Ca(OH)_2 = CaSO_3 + H_2O$$

Argall[60] gives assays of mill solutions, which indicate that the sulphocyanide varies considerably. In one instance the KCNS amounted to 0.210 per cent after the solution had passed through 11,000 tons of ore in six months. Another analysis showed 0.058 per cent KCNS after the solution had passed through 26,000 tons of ore from the same ore in thirteen months. No analysis for copper was recorded.

Clark and Sharwood[71] have published analyses of mill solutions of Homestake ore. A solution used three years on sand from oxidized ores analyzed 0.024 per cent thiocyanide (CNS), and the copper was 0.006 per cent. Another solution used for five years on tailing from mixed ore, mostly unoxidized, analyzed 0.103 per cent thiocyanide (CNS), and 0.003 per cent copper. A further solution used for nine years, after treating considerable deep-level high sulphide ore, analyzed 0.319 per cent thiocyanide (CNS) and 0.004 per cent copper. A solution used for treating slime analyzed 0.012 per cent thiocyanide and a trace of copper.

Analysis of mill solutions from the Meyer & Charlton gold mine are reported by Williams[59]. The results, in parts per 100,000, are as follows: NaCN, 38.80; $Na_4Fe(CN)_6$, 5.70; $Na_2Zn(CN)_4$, 40.80; $NaCu(CN)_2$, 6.6; $Na_2Ni_2(CN)_6$, 4.19; $NaAu(CN)_2$, 0.91; $Na_3Co(CN)_6$, 2.90; NaCNO, 7.80; Na_2SO_4, 166.30; NaCl, 46.14; $CaSO_4$, 66.00; $Ca(OH)_2$, 24.40; free NH_3, 1.36; total, 426.48. It should be noted that nickel does not form the complex cyanide given in the foregoing. Thiocyanide is not reported.

The percentage of thiocyanide increases with sulphide in the ore rather significantly. This formation of thiocyanide seems to be to some extent independent of the amount of copper in the ore, for no direct relationship can be traced between the thiocyanide and the copper assays. The problem of limiting formation of thiocyanide is suggested.

Liberation of the cyanide held in combination with cuprous cyanide ($Cu_2(CN)_2$), can be accomplished by acidification. The resulting hydrogen cyanide solution can be treated by the process of Noerdlinger and Noerdlinger[57,58], or Layng[55], or by the recent Mills-Crowe[72] process, where air is passed through the resulting solution to remove hydrogen cyanide, followed by absorption in alkali. An application of the principles of chemical engineering to modern gas-washing apparatus should suggest efficient means for applying the essential reactions; as, for example, the Feld washer, the packed tower. If it is needful to get rid of excess water, these schemes should prove of merit.

The processes of de las Fuentes[62] and of Halvorsen[63] remove the hydrogen cyanide, after acidification, by distillation of the solution under reduced pressure, followed by passing the vapors into alkaline solutions. In the processes of Porter[67], Anderson[48], Wright[69], Williamson[52], and Wheelock[50] the metallic salt precipitates are removed, and the clear solution is treated with alkali to fix the hydrogen cyanide as salt.

It is well known that a solution of hydrogen cyanide slowly decomposes on standing into ammonium formate:

$$HCN + 2H_2O = HCOONH_4.$$

Pure hydrocyanic acid is decomposed by strong hydrochloric acid into formic acid. Strong sulphuric acid effects the same change perhaps, but it breaks up formic acid into carbon monoxide and water, and no formic acid results. These reactions are probably of not much importance in regeneration of cyanide. S. Kilpi[73] deduced reaction velocities for hydrolysis of cyanides in hydrochloric and alkaline solutions. Reactions are: $RCN + H_2O = RCONH_2$ and $RCONH_2 + H_2O = RCO_2NH_4$ for both acid and alkaline solutions. The third reaction is $RCO_2NH_4 + H^+ = RCOH + NH_4^+$ for acid solutions; and $RCO_2NH_4 + OH^- = RCO_2^- + NH_4OH$ for alkaline solutions. The velocity depends on the first two steps; the third is rapid.

If copper thiocyanide is formed as the larger part of the precipitate, one or perhaps a few more mols of HCN per mol of CuCNS may be liberated by acidification, followed by one of the processes mentioned in the foregoing. Further recovery of the cyanide is dependent on a treatment of the precipitate. If the ore carries copper in an oxidized condition, the precipitate will consist of a proportion of cuprous cyanide, $Cu_2(CN)_2$, and further recovery of cyanide depends on treatment of this precipitate. It is possible to regenerate cyanide from cuprous cyanide held in solution by KCN by the methods of Leaver and Woolf[65]. The scheme is to precipitate the solution with sodium sulphide to take out the silver. Then acidification is accomplished, the copper is precipitated as cuprous sulphide, and hydrocyanic acid is liberated. By making the clear filtrate alkaline, the hydrocyanic acid is fixed as salt. Kirsebom, Anderson, Scanlon and H. B. Wright suggest similar procedures. If thiocyanide precipitate forms on acidification, this scheme will regenerate thiocyanide only from that part of the precipitate which is thiocyanide.

The following statements in Clennell's "Cyanide Handbook" are given as bearing on the problem of treating $Cu_2(CN)_2$ and CuCNS precipitates formed by acidification: $Cu_2(CN)_2$ dissolves without change in concentrated HCl, and is precipitated from this solution by H_2O or KOH. It is soluble in ammonia and in many ammonium salts, forming complex cyanides. It is decomposed by ferric chloride in the cold with evolution of cyanogen:

$$FeCl_6 + Cu_2(CN)_2 = 2FeCl_2 + Cu_2Cl_2 + (CN)_2$$

It is decomposed by acetic acid in the presence of an oxidizing agent, giving cyanogen. CuCNS is insoluble in all acids except nitric (Clennell). It reacts with caustic alkalis, giving soluble thiocyanides and cuprous oxide. Thiocyanides are oxidized by permanganate in the presence of sulphuric acid:

$$KCNS + 6KMnO_4 + 12H_2SO_4 = 11KHSO_4 + 6MnSO_4 + 5HCN + 4H_2O$$

Meade finds[74] that the action of H_2SO_4 on KCNS gives HCNS and the latter is decomposed by water in presence of excess sulphuric acid into ammonia and carbon oxysulphide:

$$HCNS + H_2O = NH_3 + COS$$

The ammonia and carbon oxysulphide may react to give urea:

$$COS + 2NH_3 = H_2S + CO(NH_2)_2$$

Nitric acid oxidizes the sulphur in thiocyanides with liberation of hydrogen cyanide, according to the equation:

$$KCNS + 2HNO_3 = HCN + KHSO_4 + 2NO$$

After absorbing the liberated hydrogen cyanide in alkali, the nitric oxide is oxidized with air and steam and recovered as nitric acid:

$$2NO + 3O + H_2O = 2HNO_3$$

It is stated that the gases contain

from 3 to 5 per cent of CO_2 and N_2O_3, showing that much excess oxidation by nitric acid in a properly conducted reaction vessel (J. T. Conroy[56] *loc.cit.*).

Walker and Eldred[74] found that "aqueous solutions of hydrogen cyanide decompose rapidly, forming a brown precipitate of azulmic acid; ammonia and oxalic acid remain." A trace of sulphuric acid stabilizes the solution.

Teherniac and Gunzberg took out a patent in 1878 on a process of heating lime, carbon, and iron with thiocyanides to obtain ferrocyanide. The yield was low.

Playfair[75] passed hydrogen over heated potassium thiocyanide:

$$4KCNS + 6H = K_2S + 2KCN + 3H_2S + 2C + 2N$$

Carbon and hydrocarbon gases substituted for hydrogen yielded no cyanide. Upon heating sodium thiocyanide with zinc or lead, a yield of 70 per cent of the cyanide was obtained:

$$NaCNS + Zn = NaCN + ZnS$$

I found that by substituting CuCNS in place of NaCNS, metallic copper and no cyanide resulted.

Conversions of 50.5 to 68.9 per cent of the potassium thiocyanide to cyanide were obtained by Conroy[56] on heating to 400 deg. C., with zinc dust. If a large excess of zinc or lead was used, 70 to 80 per cent of the thiocyanide was converted. The reaction is clearly reversible at higher temperatures. Potassium thiocyanide heated with sponge iron and pitch to 400 deg. C., with stirring gave a product containing 76.8 per cent of $K_4Fe(CN)_6$. A second experiment gave 48 per cent of $K_4Fe(CN)_6$. Irregular results are likely to occur. Attempts failed to convert thiocyanide into ferrocyanide by heating a concentrated solution in a sealed tube with iron wire.

Crowther and Rossiter[77] heated thiocyanides with zinc or lead to make cyanides. Bower[78] treats moist copper thiocyanide with iron to obtain copper and iron thiocyanide. Raschen and others[79] mix dry thiocyanide with quicklime and carbonaceous material, and heat strongly and rapidly with stirring. The mass is cooled out of contact with air and lixiviated to obtain cyanide.

Milbauer[80] reports that KCNS reacts with PbO to give PbS and KCNO between 200 and 1,200 deg. C. Zinc oxide used in place of lead oxide gave K_2S in addition. Tin oxide and K_2S react on KCNS to give K_2SnS_3 and KCN. Arsenic and antimony oxides yield the double sulphide easily. Cadmium oxide reacts similarly to lead oxide. Manganese oxide gives green amorphous Mn-sulphide. Copper oxide acts similarly to SnO_2, giving cuprosulphide and by continued heating small crystals of cupro-potassium sulphide. The following reaction also occurred:

$$KCNS + 2KCNO = K_2S + KCN + 2CO + 2N$$

At 400 deg. C., Fe_2O_3 acted on KCNS to give needles of ferrous sulphide in the double sulphide $K_2Fe_2S_4$. The KCN formed at the same time reacted with the melt in water to give $K_4Fe(CN)_6$ and FeS.

Direct fusion of copper thiocyanide with caustic soda and powdered ferromanganese gave no simple cyanide. Direct fusion of sodium thiocyanide with ferromanganese and caustic soda gave ferrocyanide and probably complex mangano- or mangani-cyanides. No simple cyanide could be identified in the melt. Sulphides were formed as the hydrogen sulphide was evolved on acidification.

Hydrogen cyanide boils at 25.65 deg. C., and is soluble in all proportions in water. Ammonium cyanide boils at 36.1 deg. C., with dissociation. Experiments were conducted on cuprous cyanide $Cu_2(CN)_2$ using ammonium sulphate and air with heat up to 350 deg. C., in attempts to volatilize ammonium cyanide. A water-white salt distilled over, which was soluble in water, contained no sulphur, was not cyanide, and gave only a trace of cyanide. It precipitated a white silver salt from silver nitrate in varying amounts, depending on the degree of acidity, using sulphuric acid. Parallel tests with silver cyanide gave no such variation.

Heating of cuprous cyanide very slowly with ammonium chloride to 350 deg. C. gave about 1 per cent yield of ammonium cyanide.

Cuprous cyanide was heated in a stream of ammonia and steam up to 420 deg. C. Only traces of cyanide were found in the delivery apparatus.

Cuprous cyanide was heated to 400 deg. C. with ammonium cyanide and pulverized charcoal. Only traces of cyanide were found in the delivery apparatus. The same aforementioned white salt formed and condensed in the delivery tube, but no cyanide was found.

Distillation of cuprous cyanide in hydrochloric acid solutions yielded 80 per cent of the cyanide as HCN, which was absorbed in alkali. Under a vacuum of 24 in. of mercury the yield was 93 per cent.

The reaction of cuprous cyanide with nitric acid gave yields of the cyanogen as HCN of 71.5, 71.6, and 88.7 per cent in three distillations carried out under vacuum, 20 to 24 in. mercury.

Cuprous cyanide yielded traces of cyanide on boiling with sulphuric acid. Oxygen or oxidizing reagents must be supplied to change cuprous to cupric copper, inasmuch as copper gives a very low concentration of cuprous sulphate. The reaction gives ammonia in absence of air; 11.7 per cent cyanide as HCN was recovered by passing air through a boiling dilute (1:2) sulphuric acid suspension of $Cu_2(CN)_2$. Two grams of cuprous cyanide, four grams of ammonium chloride, and 75 c.c. of water were distilled under a vacuum of 20 to 24 in. mercury. The distillate gave 2.4 per cent yield of cyanide. This was an attempt to adapt French patent No. 347,373, Oct. 24, 1904, to Badische-Anilin und Soda Fabrik, which specifies distillation of impure cyanides with a solution of an ammonium salt. The ammonium cyanide formed is received in an acid or alkaline solution.

An experiment using hydrogen sulphide to liberate hydrogen cyanide from cuprous cyanide (Williamson process) in water suspension gave 92.2 per cent yield of cyanide.

Cuprous cyanide is slowly oxidized by air in hydrochloric acid solutions at ordinary temperatures. Heating hastens the oxidation with destruction of the cyanide. A similar reaction occurs with sulphuric acid. Air was bubbled directly into the solutions. Sulphur dioxide and air bubbled through a boiling suspension of cuprous cyanide gave traces of cyanide evolution.

Heating of the dry cuprous cyanide, caustic soda and charcoal resulted in liberation of metallic copper. A trace of cyanide was found in the lixiviation filtrate. Boiling of cuprous cyanide with ammonia gave traces of cyanide in the distillate.

Two grams of copper cyanide and 4.3 grams of potassium cyanide were heated in solution until clear; 4.1 grams of ammonium chloride and 4.1 grams of lime were added, and the solution (500 c.c.) was heated to 80 deg. C., and filtered hot; 99 per cent of the original copper was found in the filtrate. No copper was precipitated after heating for several hours. This was an attempt to follow ammoniacal precipitation from cyanide solutions (Burr).

Several electrolytic experiments on electrolysis of cuprous cyanide in alkaline solutions in a diaphragm cell were performed. About 40 per cent yield was obtained. It was found that when the KCN concentration became 0.5 per cent no further cyanide was regenerated, which confirmed the data of Watts and Brann. Electrolysis of hydrochloric acid solutions of copper cyanide in a diaphragm cell yielded 81 per cent of the cyanide. Inasmuch as HCN is dissociated to the extent of 0.011 per cent in a 0.1 molar solution, little of the CN ion is carried to the anolyte by the current.

Considerably more literature on the treatment of thiocyanides for recovery of cyanogen as cyanide is extant than on cuprous cyanide. The processes of Raschen and of Layng (*loc.cit.*), where nitric acid or nitrates are employed, would hardly be of use in a recovery process in the usual size of cyanide mill. Nitric acid must be regenerated, and the plant required is not simple. Stoneware or other acid-resisting apparatus would be required. Yields of 27.5 to 62.7 per cent of cyanide were obtained from copper thiocyanide, depending upon nitric acid concentrations used and the manipulation. Large-scale manipulation could no doubt be regulated so as to give a larger yield. Over-oxidation must be avoided. This method is likewise applicable to treatment of cuprous cyanide. Raschen[81] has patented the use of nitrates, chromates, lead dioxide, and manganese

dioxide in the presence of sulphuric acid for the production of cyanide from thiocyanides.

Distillation of copper thiocyanide with manganese dioxide and sulphuric acid under vacuum yielded 10 per cent of the contained cyanogen as cyanide. Trial was made of bleaching powder (CaClOCl) as an oxidizing agent for cupro thiocyanide in the presence of hydrochloric acid. The distillate gave a trace of cyanide. Ferric chloride and cupric chloride as oxidizing agents proved to be too feeble for the treatment of copper thiocyanide. Passing air through a boiling solution of sulphuric acid with copper thiocyanide in suspension gave a trace of evolved cyanide. A hydrochloric acid solution in a similar manner gave a trace of cyanide. A fusion of copper thiocyanide with caustic soda, charcoal, and iron filings gave off ammonia. No simple cyanide was found in the product.

Several experiments were made which confirmed the results of Crook, Booth, and Thiel, that with an alkalinity of over 0.4 per cent NaOH, when electrolysis of a sodium thiocyanide solution is performed, no cyanide results. The anodic oxygen potential is evidently quite critical for a satisfactory result as indicated by the equation:

$$NaCNS + NaOH + 3O = NaCN + NaHSO_4$$

To limit the alkalinity and yet to have sufficient alkalinity present at all times, the experiment was performed using lime: 500 c.c. of solution with 3.32 per cent of NaCNS and 20 grams of lime were electrolyzed with graphite cathode 1¾ x 5 in., and a lead anode of the same submerged area. The time was 27 hours 44 min.; voltage was 5.53; amperes were 0.925; 1.37 grams of sodium cyanide was found in the electrolyte. Current efficiency was 17.5 per cent based on oxidation of sulphur to H_2SO_4. The final electrolyte smelled strongly of ammonia. Considerable ammonia and cyanide were volatilized as NH_4CN from the open vessel during the electrolysis. Cathodic hydrogen reacts with cyanide to give ammonia.

Lime in equivalent amount on boiling with cuprous thiocyanide resulted in 38 per cent of the thiocyanide passing into solution as calcium thiocyanide. Doubling the lime gave 47 per cent of the thiocyanide as calcium thiocyanide. Sodium hydroxide heated in solution with an equivalent amount of copper thiocyanide gave 80.3 per cent of the thiocyanide as sodium thiocyanide: Na_2CO_3 does not act on CuCNS.

It appears that any electrolytic treatment of thiocyanide would be most successful if the cyanide were removed from the cell as rapidly as formed. Parker and Robinson's proposals, using an acid electrolyte, may result in incomplete decomposition of the thiocyanide into ammonia and carbon oxy-sulphide. And direct use of copper thiocyanide is hardly possible, on account of its insolubility.

The following electrolytic experiment, using a porous cup diaphragm, was tried, with lead anode and graphite cathode: The anolyte was 1,000 c.c. of 1.22 per cent NaCNS solution. The catholyte was sodium sulphate solution. Volts were 7.46; amperes, 1.88; time, was 6½ hours; 1.56 grams of equivalent NaCN was found in the anolyte. Traces were found in the catholyte. Current efficiency was 41.9 per cent, based on oxidation of sulphur to H_2SO_4. Here the anolyte became acid while the catholyte became alkaline. A further electrolysis of a 1.63 per cent NaCNS anolyte was made. The anolyte was 1,000 c.c., with 5 c.c. of concentrated sulphuric acid added. The catholyte was sodium sulphate solution. Volts were 6.59; amperes, 1.88; time was 6 hours 50 min. Heat was applied to the anolyte; 2.42 grams of equivalent sodium cyanide was found in the anolyte, or 61.9 per cent current efficiency. The anolyte became colored a light brown.

If ferrocyanides accumulate in the circuit, their removal can be effected by adding cupric or cuprous salts at the time acidification is accomplished. If copper is already present, precipitation of cupro-ferrocyanide may result. The literature was consulted for treatment of ferrocyanides to give simple cyanide. The method applicable to production of alkaline cyanides from ferrocyanides by fusion with alkaline carbonates is not applicable because of the copper present. Everitt[81] distilled potassium ferrocyanide with sulphuric acid and gave the reaction:

$$K_4Fe(CN)_6 + 3H_2SO_4 = 3KHSO_4 + KFe(CN)_2 + 3HCN$$

Sims and Bowes[82] have patented this reaction for production of cyanides. Mueller[83] treats ferrocyanides with metallic copper in the presence of an acid capable of reacting with ferrocyanide, the hydrogen cyanide being distilled.

Distillation of potassium ferrocyanide with dilute sulphuric acid (1:2) under vacuum gave 0.5 per cent yield of the cyanogen as cyanide. A more dilute acid should give more cyanide. When hydrochloric acid was used in place of sulphuric acid the yield was 40.8 per cent. Distillation of potassium ferrocyanide with hydrochloric acid in the presence of copper filings under vacuum yielded 76 per cent of the cyanogen as cyanide. When cupro-ferrocyanide with copper filings and hydrochloric acid was used in place of potassium ferrocyanide, the yield was 71 per cent.

E. Bergmann[84] treats ferrocyanides with copper or silver salts in dilute solution, to form cuprous cyanide or silver cyanide:

$$Cu_4Fe(CN)_6 + Cu_2Cl_2 = 3Cu_2(CN)_2 + FeCl_2$$

The cupro-cyanide is treated with alkaline sulphides for the production of double cyanides. I found that cupro-ferrocyanide, distilled with hydrochloric acid in the presence of cuprous chloride, gave hydrocyanic acid. The yield was 21 per cent without vacuum.

Christy[85] obtained regeneration of simple cyanide from ferrocyanide by electrolysis at 4 volts (*loc.cit.*)

The process of MacArthur for sludge precipitate was investigated for cuprous cyanide. By boiling cuprous cyanide with caustic soda it was found that 62 per cent of the caustic was transformed into sodium cyanide combined with copper cyanide. Excess of copper cyanide was present. A method of recovery based on this reaction, followed by acidification to liberate the bound cyanide, would require a prohibitive amount of caustic soda.

Muhlert[85] suggests that the reaction

$$CuCNS + Cu + H = Cu_2S + HCN$$

may be made effective by heating. Experiments were made using powdered ferromanganese in place of copper. The heating was from 300 to 360 deg., C. The yield of cyanide was from 1.3 to 22.0 per cent. Higher temperatures seemed to cut down the yield. Several experiments were made in attempts to carry through the reaction suggested by Muhlert. Finely divided copper was obtained by precipitation from copper sulphate with iron. The constituents were ground together in an agate mortar. Heating was extended over two to three hours, and the temperatures employed varied from 150 to 300 deg., C. in five experiments. Only traces of titratable cyanide were given off. Trial was also made using CuO in place of copper according to the reaction:

$$CuCNS + CuO + 3H = Cu_2S + H_2O + HCN$$

Two trials were made by heating slowly to 300 and 360 deg., C. No simple cyanide was evolved.

Conclusions

Electrolytic schemes used on original-ore cyanide solutions so far tried have not been very successful in precipitating copper and at the same time regenerating the cyanide. The difficulties have been partly pointed out. A further operating trouble may occur in that calcium sulphate may crystallize out on the anodes, especially where thiocyanides are present. Ammonia cyanide treatments do not seem to have had much vogue outside of the laboratory. Regeneration by acidification of residual mill solutions, proposed as early as 1889 (MacArthur), precipitation as a sludge of the troublesome copper compounds, and further treatment of the clear liquid by alkalies, either directly or by removing hydrogen cyanide as a vapor with subsequent absorption in alkali, appears to be the most effective method. Acidification is accomplished with sulphur dioxide or sulphuric acid. Removal of the liberated hydrogen cyanide is made possible by distillation under vacuum or by passing air through the solution. The resulting vapors are passed through alkaline solutions to fix the hydrogen cyanide. This procedure will recover about 50 per cent of the "bound" cyanide, depending upon the copper and sulphur compounds originally present in the ore.

I suggest that the processes of Leslie[86] could be incorporated with those of a regenerative nature on resid-

ual cyanide solutions involving absorption of HCN gas from air by passing through alkaline solutions. Leslie proposes to cover the cyanide tanks and to draw off the HCN-gas-laden air which is passed through alkaline solutions. White[87] determined that 25 per cent of the cyanide used in South Africa passed off as HCN gas. The gas scrubbing arrangements for the one operation could be made to serve for the other at the same time.

The further recovery of cyanide involves methods of treating the sludge precipitate. These methods must be adapted to the precipitate. If it is largely cuprous cyanide, treatment with hydrochloric acid or with salt and dilute sulphuric acid will recover a large proportion of the cyanogen. Electrolysis of an acid solution in a diaphragm cell to remove copper, leaving HCN gas or solution at the cathode, may be suggested. The process of MacArthur for the treatment of sludge with caustic alkalies as outlined in the foregoing is simple if the sludge is cuprous cyanide, but costly. If it is found upon acidification that the precipitate is largely cuprous cyanide, precipitation of the copper by sodium sulphide by the schemes suggested by Wright, Kirsebom, or by Leaver and Woolf should be the simplest and cheapest.

If the sludge precipitate is largely cuprous thiocyanide, treatment with caustic soda followed by electrolysis of the acidified filtrate in a diaphragm cell has possibilities, although the energy requirements are very high and any process based on these facts would be complicated. If thiocyanides form in working solutions, their removal is possible by precipitation with cuprous salts added before or just at the time of acidification. Recovery of cyanide from thiocyanide involves either one of two things: The sulphur must be split from the thiocyanide by oxidizing it or by causing it to combine as a sulphide with some metal. In this connection the process suggested by DuBois[88] or some variation of it may have possibilities.

I wish to acknowledge with thanks many helpful criticisms made by Prof. G. A. Guess, of the University of Toronto.

[A paper by C. W. Lawr on cyanide regeneration as practiced by the Compañia Beneficiadora de Pachuca, printed as Technical Publication No. 208 by the A.I.M.E., contains much information on this subject. An abstract will be published in an early issue.—EDITOR.]

BIBLIOGRAPHY

1. Butters and Clennell—*Eng. & Min. Jour.* Vol. 54, p. 391.
2. P. Argall—*Eng. & Min. Jour.* Vol. 64, p. 278.
3. Julian & Smart—"Cyaniding Gold and Silver Ores," 2d edit., pp. 112, 241, 236.
4. D. L. H. Forbes—*Trans.* A.I.M.E. Vol. 43, p. 471.
5. W. Dixon—*Proc.* Royal Soc. N.S.W. Vol. 11, p. 93.
6. Sir E. Thorpe—"Dictionary of Applied Chemistry."
7. Ferguson and Sturtevant—*Trans.*. Amer. Electrochem. Soc. Vol. 38, p. 167.
8. J. L. R. Morgan—*Zeit. f. Phys. Chem.* Vol. 17, p. 513.
9. F. C. Frary—*Trans.* Amer. Electrochem. Soc. Vol. 31, p. 309.
10. W. J. Sharwood—*Jour.* Amer. Chem. Soc. Vol. 25, p. 580.
11. F. Spitzer—*Zeit. f. Elektrochem.*, 1905, Vol. 11, pp. 345, 391.
12. Allmand and Ellingham — "Applied Electrochemistry," pp. 64, 357.
13. W. Virgoe—*Bull.* Inst. of Min. & Met., Dec. 19, 1901.
14. H. Barker—*Jour.* Soc. Chem. Ind., June, 1903, p. 744.
15. S. B. Christy—U. S. Bureau of Mines Bulletin No. 150, p. 37.
16. G. H. Clevenger—*Trans.* Amer. Electrochem. Soc. Vol. 28, p. 263.
17. G. H. Clevenger—*Eng. & Min. Jour.* Vol. 102, p. 579.
18. J. Clennell—*Eng. & Min. Jour.*, May 27, 1911, p. 1064.
19. C. Richmond—*Eng. & Min. Jour.* Vol. 83, p. 512.
20. H. Rose—*Trans*, A.I.M.E. Vol. 55, p. 430.
21. E. Kern—*Trans.* Amer. Electrochem. Soc. Vol. 24, p. 241.
22. Clevenger and Hall—*Trans.* Amer. Electrochem. Soc. Vol. 24, p. 271.
23. C. Rice—*Eng. & Min. Jour.* Vol. 83, p. 269.
24. T. K. Rose—*Trans.* Inst. Min. & Met. Vol. 8, p. 369.
25. A. Von Gernet—*Proc.* Met. & Chem. Soc. of So. Africa. Vol. 1, p. 30.
26. Hussey—U. S. Patent 1,324,352, 1919.
27. L. H. Duschak—U. S. Patent 1,699,350, 1929.
28. W. H. Davis—U. S. Patent 741,231, *Electrochem. Ind.* Vol. 2, p. 187.
29. T. H. Aldrich—*Trans.* A.I.M.E. Vol. 42, p. 746.
30. C. A. Chase—*Trans.* A.I.M.E. Vol. 42, p. 694.
31. I. Kitsee—U. S. Patent 1,081,596, 1913.
32. W. Orr—U. S. Patents 687,258; 689,017; 689,018, 1901.
33. J. Pfleger—British Patents 16,736; 16,737, 1895.
34. O. P. Watts and A. Brann—*Trans.* Amer. Electrochem. Soc. Vol. 31, p. 303.
35. D. Lay—*Eng. & Min. Jour.* Vol. 110, p. 58.
36. J. Withrow—*Jour.* Amer. Chem. Soc. Vol. 28, p. 1350.
37. U. C. Tainton—U. S. Patents 1,251,302, 1,334,419; *Eng. & Min. Jour.* Vol. 121, p. 112.
38. Jarman and Brereton—*Trans.* Inst. Min. & Met. Vol. 14, p. 289.
39. J. Clennell—"Cyanide Handbook," pp. 112, 113.
40. Mosher and Ludlow—*Electrochem. Ind.* Vol. 6, p. 128.
41. G. M. Burr—*Min. & Met.* Vol. 6, p. 253.
42. C. Spearman—*Can. Chem. & Met.*, March, 1925, p. 55.
43. J. W. Ryan and S. V. Cathcart—Thesis, University of Toronto, April, 1925.
44. R. Gahl—*Eng. & Min. Jour.-Press.* Vol. 117, p. 107.
45. P. DeWilde—*Jour.* Chem. & Met. Soc. of So. Africa. Vol. 1, p. 65. *Mines & Minerals.* Vol. 31, p. 342.
46. Caldecott and Johnson—*Electrochem. Ind.*, 1902, p. 494.
47. L. E. Porter—U. S. Patent 759,220, 1904.
48. Anderson and Scanlon—U. S. Patent 778,348. 1904.
49. Wright—U. S. Patent 861,628. July 30, 1907.
50. R. P. Wheelock—U. S. Patent 996,179.
51. M. W. VonBernewitz—"Cyanide Practice, 1910-13."
52. W. Williamson—*Jour.* Chem. & Met. Soc. of So. Africa. Vol. 12, p. 403.
53. G. N. Kirsebom—*Eng. & Min. Jour.* Vol. 124, p. 817.
54. H. R. Layng—U. S. Patent 1,183,086. 1916; and *Min. & Sci. Press*, Vol. 109, p. 481.
55. Raschen, Norman and Luxton and United Alkali Co.—British Patents 10,476, 1895; 21,678, 1895; 12,180, 1901.
56. J. T. Conroy—*Jour.* Soc. Chem. Ind. May 31, 1899, p. 432.
57. Noerdlinger and Noerdlinger—British Patent 17,690, 1906.
58. H. R. Layng—U. S. Patent 1,178,031, 1916.
59. H. Noerdlinger—U. S. Patent 897,735, 1908.
60. H. B. Wright—*Eng. & Min. Jour.* Vol. 115, p. 806.
61. Burk and Pettis—*Min. & Met.* Vol. 6, p. 136.
62. J. S. McArthur—British Patents 3071, 3072, 1889.
63. J. de Las Fuentes—Canadian Patent 157,530, 1914.
64. H. Itzig—*Berichte* 35 (1), p. 106.
65. S. B. Christy—*Trans.* A.I.M.E., 1896, p. 1.
66. Crook, Booth and Thiel—*Met. & Chem. Eng.* Vol. 14, p. 587.
67. Parker and Robinson—British Patents 17,407, 1888; 2,383, 1889.
68. A. Du Bois—French Patent 580,576, 1924.
69. P. Argall—*Eng. & Min. Jour.* Vol. 64, p. 246.
70. H. E. Williams—*Jour.* Chem. & Met. Soc. of So. Africa. Vol. 14, p. 475.
71. Clark and Sharwood—*Bull.* Inst. Min. & Met., Nov., 1912.
72. A. W. Allen—*Eng. & Min. Jour.-Press*, Jan. 16, 1926, p. 112.
73. S. Kilpi—*Zeit. f. Phys. Chem.* Vol. 86, pp. 641, 740.
74. Walker and Eldred—*Jour.* Ind. & Eng. Chem. Vol. 17, p. 1074.
75. D. J. Playfair—*Jour.* Soc. Chem. Ind. 1892, p. 14, British Patent 7,764, 1890.
76. J. T. Conroy—*Jour.* Soc. Chem. Ind. 1896, p. 8.
77. Crowther and Rossiter—British Patents 8,305, 1894; 8,669, 1895; 9,275, 1894; 21,451, 1893.
78. H. Bower—British Patent 8,330, 1895.
79. Raschen, Davidson and Brock—British Patent 24,814, 1894.
80. J. Milbauer—*Zeit. f. Anorg. Chem.* Vol. 42, p. 433.
81. Everitt — *Philosophical Magazine*, Vol. 6, p. 97.
82. Sims and Bowes—British Patent 2,929, 1906.
83. M. E. Mueller—U. S. Patent, 1,347,518.
84. E. Bergman—British Patent 4,095, 1890.
85. F. Muhlert—"Die Industrie der Ammoniak und Cyanverbindungen."
86. H. M. Leslie—British Patents, 28,235, 27,879, 1911; 22,909, 1912; also *Jour.* Chem. & Met. Soc. of So. Africa. Vol. 16, pp. 36-49, 77-79, 110-113.
87. H. A. White—*Jour.* Chem. & Met. Soc. of So. Africa. Vol. 16, pp. 192-3.
88. E. S. Leaver and J. A. Woolf—Reports of Investigations, U. S. Bureau of Mines, Serial 2,883, July, 1928.

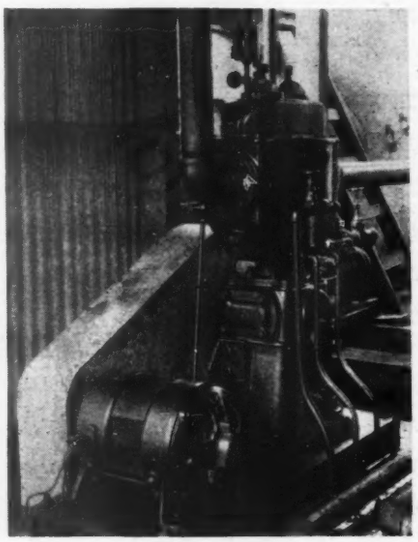
USEFUL OPERATING IDEAS

Equipping a Mine With a Timber Treatment Plant

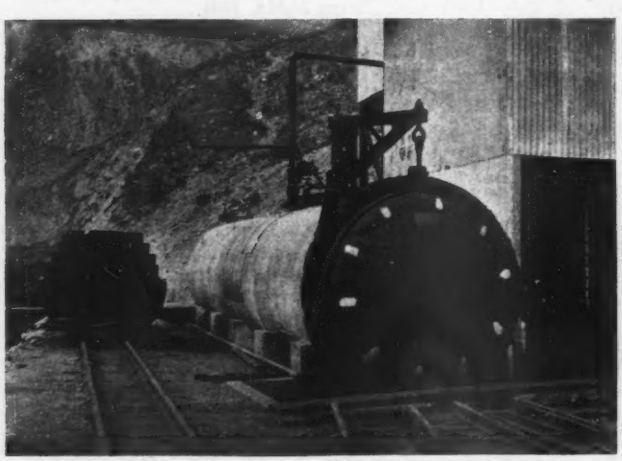
United Verde Installs Zinc Chloride Impregnation Process at Jerome, Arizona

THE United Verde Copper Company has recently installed and placed in operation timber-treatment equipment at its Jerome, Ariz., plant. The retort is 5 ft. 6 in. in diameter and 32 ft. in length. Vacuum is created by an Ingersoll-Rand 10x5 Imperial Type 15, vertical double-acting unit. A 5½x3½x5-in. duplex pump is used for transferring zinc chloride solution and for impregnating under pressure. Measuring and solution storage tanks as well as the vacuum and pressure pumps are housed in.

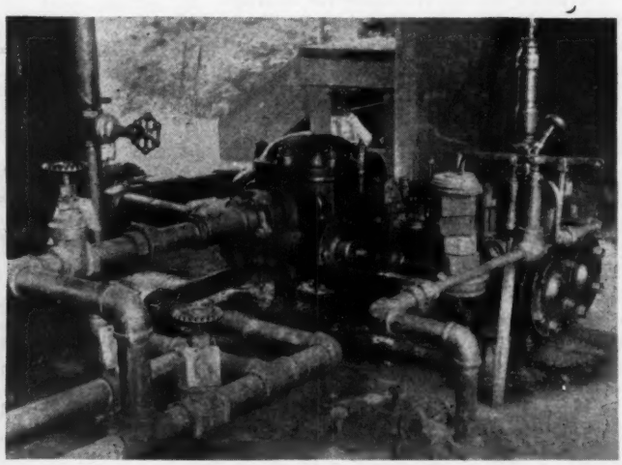
Zinc chloride solution is prepared in a 1,000-gal. tank provided with steam coils and is pumped to a 5,000-gal. storage tank. The retort charge is planned for 310 cu.ft. of timber and 750 gal. of 3 per cent zinc chloride solution. The retort is filled by gravity, taking advantage of the vacuum. An impregnating pressure is maintained at 150 lb. by the duplex pump, which is equipped with a pump governor to maintain constant pressure. Temperature of impregnation is 180 deg. F. and is obtained by 180 sq.ft. of radiation in 2-in. pipe coils in the retort. A timber charge is figured in board feet, and it is expected that the absorption rate will be about 1 gal. of 3 per cent solution per 5 b.ft. Absorption is measured by a measuring tank, allowance of 20 per cent being made for return solution. The retort is drained by means of compressed air at 100 lb. pressure, which is obtained from the mine service air line and by the application of vacuum for a period of 30 min. before the timber is removed from the retort. Under present operations 2,600 b.ft. has been treated per charge. Mine cribbing, permanent gangway sets, and second flooring in stopes, as well as fencing timber, chute boxes, and mine ties, are being treated. The plant was supplied by the J. P. Devine Manufacturing Company, of Buffalo, N. Y., and is patterned after the plant now being used at Miami, Ariz., by the Miami Copper Company.



Vacuum pump for timber-treatment retort



Retort, 5 ft. 6 in. in diameter and 32 ft. long, in which the timber is treated



Duplex pump which transfers zinc chloride solution to the retort

Shearing Assay Silver Wire Accurately

MEASURED LENGTHS of silver wire are used extensively by assayers who wish to avoid the labor and time necessary to weigh the amounts needed for parting. The same shearing accuracy is needed at electrical works employing silver wire for contact points. The solution of the assayer's problem may be borrowed from the electrical industry and adapted for specific needs. Charles H. Willey describes in a recent issue of *American Machinist* a vise shear devised for this purpose, as shown in the accompanying sketch. Two round

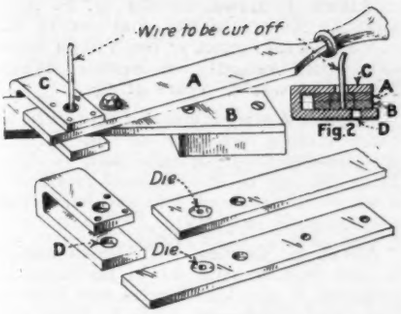


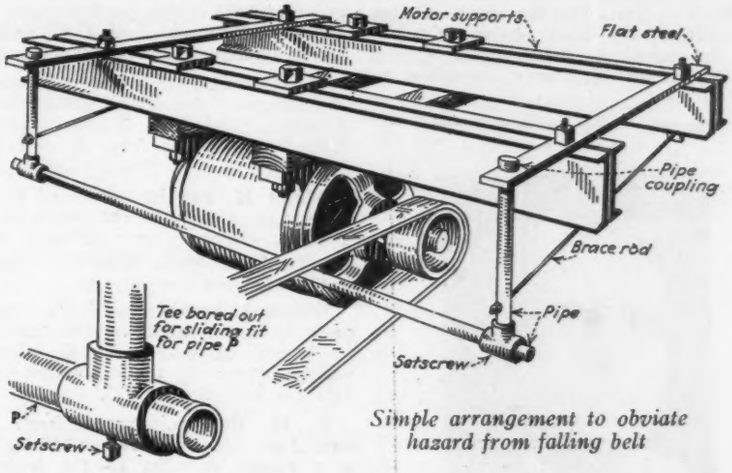
Fig. 1—Vice shear for cutting wire

dies were placed in the bars *A* and *B*, the lower bar being of a thickness corresponding to the length of wire required, at the part where the gaging clamp *C* works.

The action of the device is as follows: The shear is opened and the wire fed into the upper and lower holes of dies. Its end strikes the plate of the gaging clamp as in Fig. 2. The shear is closed and the wire cut off. The piece drops out of the hole *D*.

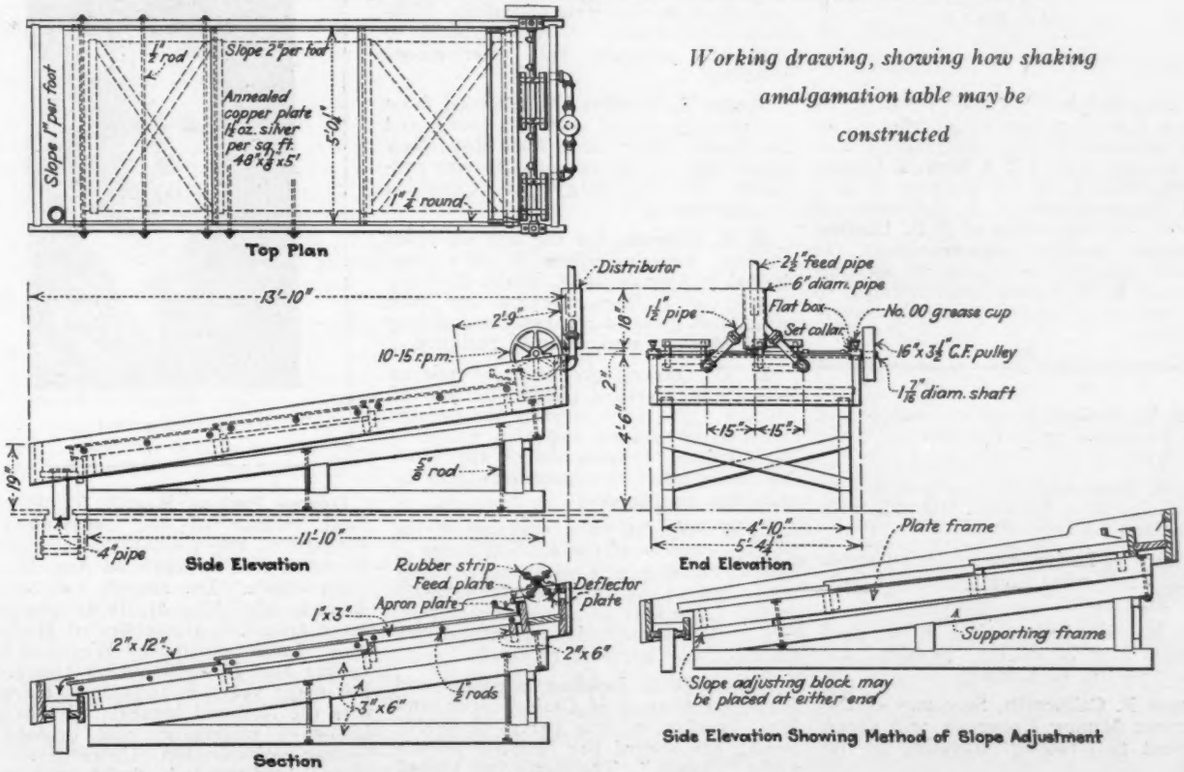
Safety Bar Prevents Damage From Falling Belts

A MOTOR BELT sometimes runs off the pulley. When the motor is a large one, and hung from the ceiling, the falling belt may cause considerable damage, writes W. T. Clayton, Jr., in *Industrial Engineering*. To obviate this, a safety bar may be provided, as illustrated herewith, which prevents injury to plant and workmen and facilitates the replacement of the belt. When necessary the bar can be removed easily by loosening the setscrews in the tees at the ends.



Simple arrangement to obviate hazard from falling belt

Shaking Amalgamation Table Simulates Stamp-Mill Flow



Working drawing, showing how shaking amalgamation table may be constructed

RECENTLY during the building of a concentrating and amalgamating mill, writes F. C. Torkelson, engineer for the General Engineering Company, we were confronted with the problem of designing an amalgamating table that would duplicate the surging action of the pulp over the plates as caused by stamps dropping in a mortar. This was accomplished by placing at the feed end of the table a rotating shaft with four paddles attached. These paddles have rubber wearing strips bolted to them, which can easily be replaced when worn out. Ten to fifteen revolutions per minute was found to give the best results, although the speed required depends upon the amount of feed; more feed calls for more speed. The feed paddles should never be run less than 10, and never more than 15 r.p.m. The feeding arrangement, as shown, with dash-pot distributor and feeder paddles, gives a satisfactory riffle which moves over the plate in a surge from 20 to 30 times a minute. Several of these amalgamating tables are in use and they are doing excellent work. Grinding in this case is done in a ball mill.

Personal Notes

W. M. Saben, assistant manager of the Morenci branch of the Phelps Dodge Corporation, has been appointed assistant manager of the Copper Queen branch, at Bisbee, Ariz., according to

W. M. SABEN

an announcement made recently by **Frank Ayer,** manager at Morenci. Further changes in the organization are: the appointment of **I. J. Simcox,** smelter superintendent, to the position of general superintendent of the Morenci branch; the promotion of **J. G. Lindley,** assistant smelter superintendent, to smelter superintendent; and the appointment of **E. G. Lewis,** chief chemist, to the position of assistant smelter superintendent.

Ira B. Joralemon, mining engineer, of San Francisco, recently returned from Ely, Nev.

G. A. Joslin expects to return to Los Angeles on Sept. 1, from a trip to British Columbia.

Robert F. Lethbridge has left Canada for England, where his address is Saltford, Somerset.

H. W. Hardinge sailed from New York on Aug. 23, on the "Bremen," for a business trip to Europe.

James F. Callbreath, Secretary of the American Mining Congress, will spend the next two months traveling in the West.

Sydney H. Ball, of Rogers, Mayer & Ball, mining engineers, of New York City, is making an examination in Canada.

E. D. Foster, mining geologist, of Los Angeles, recently examined the Gold Nugget property, near Silver City, New Mexico.

Pierce C. Walker recently accepted a position as chief engineer for Banner, Snow Creek, and Record Mining, in eastern Oregon.

E. H. Rose, mill superintendent for Moctezuma Copper, at Nacozari, Mexico, is in Nevada and Utah studying recent changes in flotation practice.

H. H. Fraser, until recently manager of Loangwa Concessions, Ltd., Northern Rhodesia, and Mrs. Fraser arrived in New York City on Aug. 26 from South Africa.

Albert H. Fay has returned to New York City after a month spent in New Mexico, Colorado, and Arizona, where he examined mining properties for New York interests.

Walter A. RuKeyser, mining engineer, of New York, sailed on the "Bremen" on Aug. 23 en route to Russia, where he will supervise the modernization of the asbestos industry.

T. H. Rea, mining engineer, was elected president of Newbec Mines, Ltd., at a recent meeting of the board of directors. He succeeds **A. B. Gordon,** who remains on the board as a director.

C. K. Leith, of the University of Wisconsin, conducted a general conference recently at the Institute of Politics, Williamstown, Mass., on the subject of Canada's minerals and international relations.

Arthur L. Walker has returned from a European trip of several months, and has opened offices at 15 Park Row, New York City. Until recently he was professor of metallurgy at Columbia University.

R. A. Conrads, for the last six years general superintendent of the San Rafael y Anexas mine, in the Pachuca district of Hidalgo, Mexico, has been appointed director general, succeeding **Fred McCoy,** who recently resigned.

L. C. Graton, professor of mining geology at Harvard University, arrived at Salt Lake City recently, to present methods of taxation and mine valuation to the joint commission of the Utah legislative advisory commission and the state tax commission.

C. W. Wright, chief engineer of the mining division of the U. S. Bureau of Mines, recently met with the advisory committee of the Intermountain station at Salt Lake City for a conference relative to mining methods and microscopic, flotation, and grinding research.

Colonel **D. C. Jackling,** president and managing director of Utah Copper, and Mrs. Jackling with a party of twelve guests, are aboard the Jackling private yacht "Cyprus." The party has visited Norway and when last heard from was cruising north of Scotland.

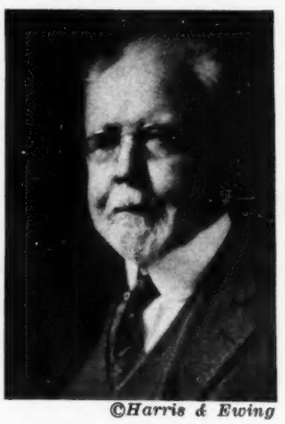
OBITUARY

M. J. Brophy, retired mining man, died late in August, in San Francisco, at the age of 69. He was associated with the Phelps Dodge interests at Bisbee, Ariz., for many years

Albert J. Lowe, former U. S. Marshall at Nome, Alaska, and one of the most colorful figures of the Yukon boom days, died recently in Seattle, Wash. Mr. Lowe was 67 years of age.

Colonel **Walter Herd,** of Chester, N. S., chief mining engineer of the British Empire Steel Corporation, died on Aug. 23 at the age of 45. Colonel Herd was a native of Scotland, and had been with the company since 1913.

Alfred H. Cowles, well-known metallurgist, died on Aug. 13, at his home in Sewaren, N. J. Mr. Cowles was born in Cleveland, Ohio, on Dec. 8, 1858, the son of a newspaper editor. He was the inventor of the process of electrolytic reduction of aluminum which made this metal available to commerce. He was educated at Ohio State and Cornell universities, and at the latter place was a member of a celebrated rowing crew. After leaving college he joined his brother Eugene in prospecting in Mexico. He was connected with the development of, and later president of, the Pecos Copper Company. In 1886, the Cowles brothers developed and built the first electric furnace. The late Mr. Cowles was a member of many engineering societies, and held several medals awarded him for his outstanding achievements.



©Harris & Ewing

G. P. MERRILL

George Perkins Merrill, for 32 years head curator of the department of geology of the United States National Museum, died suddenly on Aug. 15, of a heart attack. Dr. Merrill was born in Auburn, Me., May 31, 1854. He graduated from the University of Maine in 1879. Later he attended Wesleyan University and Johns Hopkins University. For many years, in addition to his work with the National Museum, he was professor of mineralogy and geology at George Washington University. Dr. Merrill held the J. L. Smith gold medal of the National Academy of Sciences for research work on meteorites. His most recent work was "The First One Hundred Years of American Geology." Another recent treatise was his "Handbook of Gems and Precious Stones." Earlier publications include "Rocks, Rock Weathering, and Soils" and "The Non-Metallic Minerals—Their Occurrence and Uses." He was a member of the Geological Society of America, the American Philosophical Society, and the American Institute of Architects.

COMMENT AND CRITICISM

Charles Butters Draws From Wide Experience in Discussing Gold-Ore Treatment

Practice at a Nicaraguan property indicates that the cost of amalgamation, with imported help, as compared to the cost of other processes, using domestic labor, is prohibitive. Is the end of amalgamation near? Mr. Butters believes that it is. The principle of preliminary impoverishment is held to be sound, however. . . . At a Californian plant a plan is under way to concentrate low-grade gold ore over Deisters, amalgamating the concentrate. Mr. Butters, however, sees a wider scope for flotation, and possesses great faith in cyaniding in capable and experienced hands.

To the Editor of "E.&M.J.":

I have noticed with much pleasure that *Engineering and Mining Journal* has given considerable space in the last few months to the metallurgy of gold. Although zinc, lead, and copper are of paramount domestic interest, Canada, Australia, and South Africa, deeply interested in gold production, look to the *Journal* for enlightenment and intelligent discussion on this important subject. I congratulate the editor on his recognition of the fact that the *Journal* is not local, but represents mining in its ramifications all over the world.

To the Pullman-car mining engineer and even to the automobile mining engineer who find no difficulty in getting information on subjects in which they are interested because of their proximity to congested centers, the coming of the *Journal* is not of the same importance that it is to the mule-back engineer, to whom it is frequently his only contact with his profession. I have lived many years in isolated places and speak from experience.

Every well-written article has productive value. There is no way to make a flow sheet for any given gold ore of exactly the same character without taking into consideration circumstances with which the laboratory has no connections, yet which have to do with the ultimate recovery. Let us agree with the editor that successive impoverishment is without doubt theoretically correct,[1] but one is by no means always sure of getting the most gold by the best theoretical process. If one has a sufficiently large tonnage, so that highly paid white men can be employed to look after the amalgam and the process of amalgamation—which, by the way, requires not only honesty but a high degree of skill, very careful attention to duty, and extreme cleanliness throughout—one may consider this beautiful and direct process. Having this highly paid and efficient operator who will do his duty all the time, one will still have losses.

Amalgamation is not always first class; frequently the ore changes; some partly oxidized ore in excess passes over the plates; the pulp contains soluble salts that have not been neutralized; some one has spilt oil somewhere in mine or mill, and the amount of amalgam weighed in for that shift is less. One set of men will regularly weigh in more amalgam for their shift than another—more skill, more attention. In other words, the human element comes into the picture in amalgamation. In amalgamation one cannot recover his loss—it is down the creek as far as he is concerned or in the hands of the next operator. This highly paid man has to carry a large reserve of gold on his plates in order that they can be efficient amalgamators. A gold plate 4x8 ft. can carry 5 oz. per square foot, or 150 oz. of gold, in hard amalgam and work most efficiently. Sometimes in clean ore 1 to 2 oz. per square foot is sufficient. A big mill can carry 3,000 oz. constantly on the plates. One is paying interest on whatever gold he has locked up in amalgam, and if he wants permanently bright and dependable plates he cannot keep them robbed. Hard amalgam is very easy to lose at times. When hard enough it will grind up into the finest flour and a bright plate will have no attraction for it.

In the operation of the small mill, where one cannot afford the type of employee that the larger unit can, although one may have a similar ore, it may not be economical to make use of amalgamation. The San Albino mill, in Nicaragua, with a capacity of 80 tons daily, has been forced to abandon amalgamation. It requires three white men each eight-hour shift. A new man coming into the staff is received with more or less suspicion by the other two older men. You cannot put a native on the amalgamation; white men just won't work on the other shifts. With plates preceding concentrators we found amalgam everywhere below—on the concentrators, in every launder where the pulp circulated after amalgamation. Not much, but showing a constant loss.

The old-time mill man, amalgamator, and mechanic is gone; he does not exist. Amalgamation in out-of-the-way places with changing help will simply drive the manager crazy. He must find, under present conditions, a process that will let him sleep when he goes to bed. Every manager realizes that gold amalgam represents a constant source of temptation.

In a permanent, old mining camp, where the mill employees are well known and as trustworthy as bank cashiers, and remain on the job steadily, there is no cause for worry. Amalgamation finds a useful place. Take the case of a new mill starting in Central America, like the San Albino mill. We crushed in ball and tube mills to a final product of 10 per cent plus 200 mesh, with step grinding and tabling, collecting 50 per cent of the free gold in the concentrate, the latter being subject to continuous amalgamation over a shaking pan amalgamator, followed by stationary plates. The concentrate was collected in a small Dorr classifier 16 in. wide, which delivered it to a draining bin.

[1] Mr. Butters' comments are in regard to a statement in the issue of July 20, to the effect that "The value and logic of impoverishing a gold ore before wet metallurgical treatment is commenced have been disputed so often that data referring to precise results are of interest"—the data in question being quoted from bulletins recently issued by the School of Mines of Western Australia. The word "impoverishment" was not meant to refer solely to plate amalgamation—Editor.

This operation looked all right on the flow sheet, and I spent the money for the erection of the necessary equipment. Under the circumstances it was not the best method to collect the 50 per cent of free gold. The shaking pan amalgamator did wonderful work, but soon shook itself to pieces and required constant attention.

I was surprised to see the time required on each shift to keep the plates in perfect order and to clean the amalgam. These operations must be done by the expensive man in charge of the shift. The mills and tables and flotation could all be left to native boys, who quickly learned to run them, and they also quickly become skillful amalgamators on their own account. With a first-class mechanic in charge of the mill, and by cutting out amalgamation, one can run the three shifts with an entire force of native labor. How can one avoid the temptations produced by the sight of free gold and amalgam? In tabling, without preliminary amalgamation, the streak of free gold stands out beautifully on the tables.

Under the circumstances, at San Albino, I have decided to cut out the tables from which we obtain a $250 concentrate containing one-half of the gold as free gold, or a total of about 90 per cent of the gold from a $10 to a $12 per ton head. We add some collecting oil to the ball-mill circuit, keeping the pulp there until it approximates 10 per cent on 200 mesh, then pass the pulp containing all the gold to the 100-ton, sixteen-cell Minerals Separation machine, which leaves a residue of from 60c. to $1.50 per ton, depending on the amount of oxidized ore reaching the mill. In general, with all sulphide ore, a residue of $1 per ton can be depended upon. Ordinarily that should be good enough, but San Albino tailing after flotation can be cyanided with a consumption of less than ¼ lb. cyanide per ton, giving a residue of from 10c. to 25c. per ton in less than twelve hours, with a pulp settling so rapidly and compactly that it is safest to use Devereux agitators for treatment tanks just as if one were treating unroasted concentrates.

With such a low head value and compact settlement, filtering is an unnecessary refinement. I concur with the editor that successive impoverishment is theoretically correct, but it may not always be best economically. Tables and amalgamation require attention and trustworthy help, and in my case they must be followed by flotation, and once the flotation machine is set it requires a surprisingly small amount of attention. When this is supplemented by a small cyanide plant, which in this case is of large capacity and serves as a scavenger and safety valve, our labor problem is much simplified, and the opportunity of loss by theft is greatly reduced.

But the point is made by the editor that the recovery of free gold by amalgamation still leaves gold in the concentrate. In my case I must treat concentrate anyway. Allowing the free gold to go with the concentrate gives a concentrate worth $200 to $300 per ton, depending on the grade of the ore. Part of this gold is in solid solution with iron and arsenic and has to be given a specially low preliminary roast of between 500 and 600 deg. C., until no further sulphur dioxide is given off at this temperature, after which about 10 per cent of ground charcoal is stirred in the hot pulp, which is raked into a heap and stirred a little every fifteen minutes to prevent caking, for one to two hours. During this time further sulphur dioxide is given off and the last of the arsenic is liberated. The pulp is finally dead-roasted at 600 deg. C., the charcoal having decomposed all soluble salts at this low temperature.

Ordinarily, in dead-roasting for cyanide or chlorination treatment, a final temperature of 800 to 900 deg. C. is required. This job is best done in an old-fashioned reverberatory with three hearths, each 12 ft. wide and 14 ft. long. The furnace will finish three tons of concentrate in 24 hours with 2,000 lb. of good dry wood.

I am indebted to Dr. L. H. Duschak and his assistant, Mr. D. N. Vidensky, and the privilege of the use of the laboratory of Mr. Fred W. Bradley, for working out this problem of the treatment of San Albino arsenical flotation concentrates. By adding bullion and tailing percentage contents together, the result is regularly about 103 per cent. Retreatment of the tailing gives one more gold than the head assay—I mean actual recovered gold weighed on the scale, not a theoretical calculated weight. What happens in this case is that the process returns more gold than the assay, as was found at the high-grade mill at Nipissing. The mill beat the assay office on the rich ore.

Arsenical pyrite, carrying some of the gold and silver in solid solution, is not always completely broken down in the assay crucible. A reground slag reassayed will frequently give from 3 to 5 per cent more. That means 1 oz. on a 20-oz. head, which I have repeatedly had from the most carefully run assays. I still find myself following the editor's dictum because, by flotation preceding cyanidation, I have used impoverishment before final treatment. Now, my young friends and students, Hamilton, Beauchamp & Woodworth, of Jackson, Calif., whom I consider most skillful metallurgists in the treatment of graphitic arsenical pyrite gold ores, after several careful tests will guarantee a recovery of 97 per cent on straight cyanidation of the ore without any preliminary impoverishment. I am satisfied that they can do this with their own skillful staff. It is a job that must be done by skillful people, because reprecipitation can take place before you know it. I myself could not obtain uniform results, nor any of my people, whereas they obtain regular results because of intensive study on that type of ore for seven years at Jackson.

Nevertheless, I believe that in my case flotation, followed by cyanide to recover the last 15 per cent, is cheaper to carry out and requires a minimum of skill, with a cyanide consumption from 3 to 4 lb. per ton on the whole tonnage, against less than that of 3 per cent concentrate and less than ½ lb. of flotation reagents, which means nearly $1 a ton more for chemicals plus 10 lb. additional lime, which costs 1c. a pound. The treatment of the washed residues from flotation takes ¼ lb. of cyanide.

A skillful staff in Latin America means highly paid men who must change every two years or oftener. That means 22 months' service for 24 months' pay, plus $500 traveling expenses, or $1,000 for every man. A first-class mechanic married to a good Latin-American woman will stay with the job and learn flotation and cyanide practice, run the place with native help, and clean up once a month himself. The young college man does not enter this picture. It is no life for him. If he has the experience he can go down and teach the mechanic and the native staff and clear out. So it turns out that geography, mineralogy, topography, and humanity all have their part in the making of the metallurgical flow sheet where it is to get the most economical return. In South Africa the most economical flow sheet leaves out amalgamation. I think that amalgamation will eventually disappear in South Africa as the old mills wear out.

Where does amalgamation come in on the Mother Lode in California where a large per cent of the ore runs between $3 and $4 per ton? By means of plate amalgamation and table concentration operators claim to produce tailings of from 15 to 20c., which represents 95 per cent extraction. Having made some investigations lately in Tuolumne County, I was surprised to find the large amount of guesswork and the lack of accuracy of the statements indulged in. I admit their former low-cost mining and milling, but I am slow to admit the truth of any estimate of their losses. Few millmen are willing to take an accurate tailing sample, and gold mill assay office are not equipped to determine tailing assays accurately. A good many managers don't want to know. One manager threatened to shoot me if he ever caught me sampling his tailing. That was when I was buying tailings in South Africa, and I don't find that humanity changes much anywhere I go.

Regardless of the reports and history of the Mother Lode milling practice, I would refuse to take for granted that today amalgamation and table concentration produce the best economic result. Mr. Bradley, at Alaska Juneau, uses step grinding and tabling and discarded the old Alaska Treadwell plate-amalgamation system. He has found it more economical to make one product. It pays best to ship this product, on account of its base-metal value.

The ordinary table concentrator will

collect the finest flour gold far better than a plate, and the old-time silver grinding and amalgamation pan, developed on the Comstock, will not only get the free gold caught on the tables but by fine grinding the concentrate with lime will generally reduce its value 50 per cent, and in many cases give a 90 per cent extraction by pan amalgamation. I put the process of pan amalgamation of concentrates in successful operation for our distinguished friend, William Frecheville, now Emeritus Professor of Mining at the Royal School of Mines, who was then a young mine manager in North Carolina, 48 years ago.

The principal recollection that stands out in my memory in reference to our able professor was the English marmalade and the fine pale Bass' ale that he was thoughtful enough to consider as a necessary part of the mine stores. God bless him! The English know how to take some good customs with them when they leave the homeland.

The last big mill built in the United States of Colombia at the Constancia mine, at Anzori, in the State of Antioquia, by the Venture Corporation, of London, omitted the plates, caught concentrate and free gold together, and ran them through a launder to a Dorr classifier, which discharged on a belt delivering directly to two continuous Australian grinding and amalgamation pans, which recovered all the free gold and about one-half the gold contained in the concentrate. The pulp from the pans was dewatered, and the wet pulp delivered to the top of a Merton reverberatory furnace, which automatically dried and roasted the pulp and fed to a continuous cyanide slime plant. The mill was well designed and well erected, and it worked well. The road and the mine and mill cost approximately $2.000.000.

Unfortunately, the mine had been worked out by natives long before the company commenced to retrieve any of that $2,000,000. At Jamestown, Calif., Mr. Trimble is now building a 250-ton mill on the Jones mine, where he will steam-shovel out the outcrop for 50 ft. in depth, 100 ft. wide, and 2,000 ft. long, and crush the ore in two Universal crushers, the first 2 ft. and the second 3 ft. wide, thence to a 6x5-ft. Allis-Chalmers ball mill to 20 mesh, and then over ten Deisters. The concentrates are to be amalgamated in pans. This enterprise is estimated to cost $80,000 and to have a $2 head value. I can't see the need of preliminary amalgamation in general in any new mill to be built in the future on the Mother Lode in California. In many cases flotation can be used to best advantage either with or without tables. But it depends on what the physical examination of the ore shows, whether you are to treat oxidized or sulphide ore, the size of the mineral particles, the hardness of the ore. If much oxidized ore is to be handled, a cyanide annex would probably pay.

Coming back to the editor's statement about impoverishment: I would recommend collection of gold in the concentrate rather than on the plates and if necessary impoverish the concentrate by amalgamation before cyaniding. In South Africa we bought concentrates of an average value of 5 oz. They were weighed and assayed most carefully. At the end of the year the bullion return was 99⅓ per cent of the total gold called for. This was all extracted by the wet method. In the case mentioned by the editor, where combined treatment by amalgamation and cyanide gave a higher extraction, possibly a different procedure in the cyanide process would have produced the same result, because any gold that will amalgamate will cyanide, although it may reprecipitate rapidly in some cases if not frequently removed by filtration.

Seventeen hours is too long to allow a rich solution to remain in contact with fine ground pulp, on account of adsorption and reprecipitation. As a rule, with finely ground, highly siliceous ores or dead-roasted ores of almost any type, after the combined water has been removed by heat, neither adsorption or reprecipitation takes place.

However, I wish to congratulate Mr. W. G. Clark, research metallurgist, and Mr. B. H. Moore, lecturer in metallurgy in the School of Mines, Western Australia, on their useful and interesting investigations, and to ask them please to accept my remarks purely in the light of a discussion of their paper brought out by the desire of the editor to elicit information on the treatment of gold ores.

CHARLES BUTTERS.

Oakland, Calif.

Leaflets Facilitate Employment of Engineering Graduates

To the Editor of "E.&M.J.":

Industries, public utilities, colleges, and others who are interested in the placement of college graduates have received the personnel service of the division of engineering at Iowa State College with much enthusiasm. We have been asked by many to give the service further publicity, so that others would adopt the plan.

Enclosed is a sample leaflet, a brief article explaining the leaflet, and a copy of some of the comments we have received. We believe that you will be serving the industrial organizations of your group if some explanation of this service is made in *Engineering and Mining Journal.*

FRANK D. PAINE,
Engineering Personnel Officer,
Iowa State College of Agriculture
and Mechanical Arts.

Ames, Iowa

[The aforesaid personnel service is obviously of value in the placement of the increasing numbers of college graduates who annually are employed by the various industries. For the benefit of those unfamiliar with the service, the following is reprinted from the outline that accompanied Mr. Paine's letter:

"Every year each industry is confronted with the problem of securing engineering graduates who have the proper qualifications to meet the requirements of its organizations. Representatives of many industries visit the engineering colleges and arrange personal interviews with graduating students, whereas others encourage the applicant to forward a statement of his experience, training, and qualifications. Under either plan it is difficult for company representatives to choose men wisely.

"The personnel office of the division of engineering of Iowa State College, Ames, Iowa, has improved this condition. With the co-operation of the engineering student council, this office has published for the senior engineers of the nine departments a "Personnel Service Leaflet." This leaflet measures 3¾ by 6¾ in. and is punched to fit a standard loose-leaf cover. High-grade enamel paper stock is used, and information concerning one student is printed on one side of each leaflet.

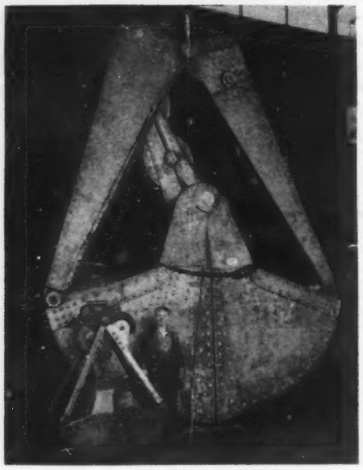
"The leaflet shows a halftone print of the student and gives his name, course, and date of graduation. Statements concerning his training, experience, and qualifications follow. These include:

"Major technical interests; college and home addresses; personal data, comprising age, height, weight, descent, church affiliations, and state of health; high school information; college information, including list of activities, and approximate portion of expenses earned, if any; practical experience, including name of employing company, address of company, and period employed by company; and date when student will be available for employment

"Fifty sets of these leaflets inserted in leather covers were sent to the leading companies of the various industries early last January. Each year refills will be sent to these companies; new sets will be sent to other companies that wish them."—Editor]

INDUSTRIAL PROGRESS

New Champions Make Their Bow in the Equipment Field



A 16½-cu.yd. clamshell in contrast with one of ¾-yd. capacity

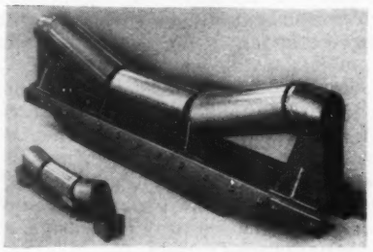
RECENT developments in the machinery field include two pieces of equipment that are styled by their makers as being the "world's largest" of their particular type. Of the latter, one is a 16½-cu.yd. clamshell bucket recently shipped to an Eastern steel company. The other its the huge set of transformers that has been built for a central station, also in the Eastern part of the United States.

World's Largest Transformers

Bridges must needs be strengthend and railroad tracks lowered 18 in. at one point to permit the transportation of the four largest electric power transformers ever built. These have been constructed by the Westinghouse company for the Pennsylvania Power & Light Company's plant at Bushkill, Pa. Each is 35 ft. high, weighs approximately 300 tons, and requires a floor space of 22x23 ft. More than three tank cars of oil, or 32,000 gal., will be required to fill each transformer. The transformers are rated at 220,000 volts, but were tested at 570,000 volts, which is said to be the highest test voltage ever applied to a power transformer. The core and coils in each contain 63 tons of laminations and 15 tons of copper windings. Each has more than 32 miles of wire in the copper windings. To meet the loading requirements of the Erie Railroad, the oil was drained from the transformers and the shipping tanks were filled with dry nitrogen gas to preserve the insulating qualities of the coils in transit.

A Clamshell of Record Size

A clamshell bucket that will pick up ten gross tons of coal at one grab has recently been built by the G. H. Williams Company, Erie, Pa., for the Donner Steel Company, Buffalo. This bucket, here illustrated, is of 16½-cu.yd. capacity. The smaller bucket shown alongside of it has a capacity of only ⅜ cu.yd. In over-all height the large bucket is 18 ft. 9 in. When opened, the scoops have a spread of 19 ft., and cover an area of 133 sq.ft. The bucket weighs 28,000 lb., which, according to the maker, is light for the size. This clamshell was designed especially to increase the capacity of a crane already in use on the steel company's docks. In general design, it is of the four-rope type, giving the operator positive control and making smooth, fast operation possible, even from a great height above the unloading point. The spread of the four lines prevents twisting or fouling.



A huge conveyor carrier built for Chile Exploration Company. The smaller one is of normal size.

This Carrier a Giant

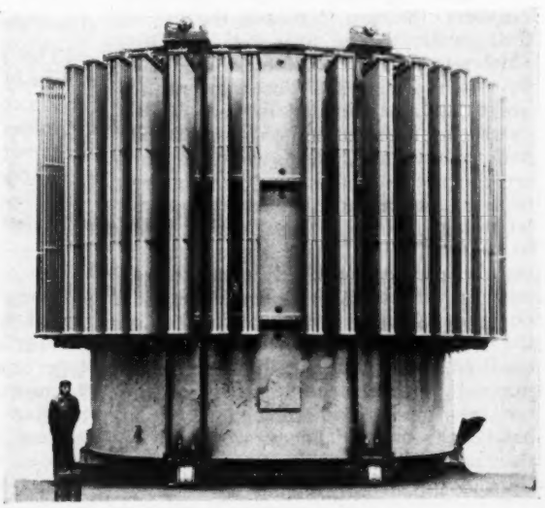
A cut on this page shows a mammoth cast-steel belt-conveyor carrier used in one of the conveyors built for the Chile Exploration Company by the Stephens-Adamson Manufacturing Company, Aurora, Ill. The huge size of this carrier is shown in the illustration, where the carrier is contrasted with one of normal size. Each large carrier weighs almost 1,000 lb. Each of the rollers turns on four Timken bearings.

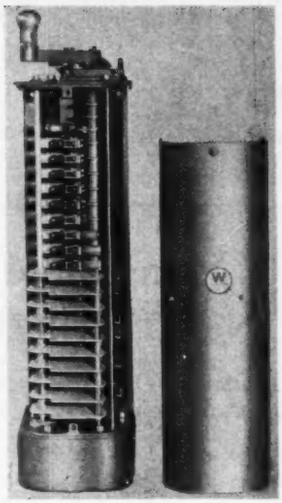
New Circuit Breaker Obviates Fuse Replacements

The Westinghouse company has placed on the market a new 15-amp. breaker, to replace the conventional panelboard toggle switch and fuse. The cost and trouble of fuse replacements is thereby avoided because, when an abnormal overload occurs on a branch circuit, the breaker opens automatically and can be immediately reclosed provided the overload condition is not sustained. The automatic mechanism trips free from the handle, so that the contacts cannot be held closed against an abnormal overload or short circuit.

The new circuit breaker consists of a toggle mechanism actuating the moving contacts and insuring full contact pressure up to the time of opening, whether actuated automatically or manually. The automatic release is secured through the action of a bimetallic thermal element that engages the releasing latch of the mechanism. The bimetallic material has been selected with great care to insure a constant calibration, and it will withstand short-circuits far in excess of actual requirements. The contacts are of non-welding material. Through the application of the Deion principle the high rupturing ability of the automatic circuit breaker is secured. The moving contact in opening passes

Four transformers such as the one shown at the right have recently been built for an Eastern power plant. They are the largest yet constructed. They are rated at 220,000 volts but were tested at 570,000 volts.





This new drum controller is intended for plant service

through a slot in a series of metallic plates insulated from one another, so that the arc is drawn through a relatively narrow passage and its heat is dissipated through absorption by the surrounding metal plates. Upon passing through the quencher plates the arc gases are expelled into an insulated expansion chamber. This chamber, formed by the base and housing, entirely isolates the gases from the branch circuit connections.

The thermal release element is designed so as to give desirable inverse time-limit characteristics. For instance, the circuit breaker will carry 10 per cent above normal indefinitely without tripping, but, when the current reaches 50 per cent above normal, the circuit breaker trips in less than two minutes. At higher overloads the time limit becomes less and less, until instantaneous tripping is secured.

The circuit breaker is inclosed in an insulated sealed housing. This prevents tampering with the mechanism or calibration unless the complete unit is removed from the panelboard and the cover unsealed. This construction, combined with the trip-free handle, successfully prevents blocking the mechanism in the closed position, as well as insuring tripping at the normal and original setting.

The housing inclosing the circuit breaker is of a cold-molded composition base and cover. For the assembled unit the space requirement is the same for the single pole circuit as for the conventional toggle switch and fuse.

Drum Controllers for Heavy Use

Westinghouse has annuonced a new line of reversing drum controllers, to be known as Type A and listed in classes 8300 and 8400 for d.c. service, and in classes 12-700 and 12-800 for a.c. service. They are intended for heavy usage in operating cranes, hoists, and railway turntables, and the like, and have several new features. The drum cylinder consists of rolled brass supporting disks assembled on a micarta insulated steel shaft between brass and micarta insulating collars. All of the contact segments are bolted to the supporting disks in such a way as to eliminate burning of the bolt heads. The segments are reversible, which doubles their life. Burned ends may be trimmed down to form shorter segments, thus reducing the stock of renewal parts required.

The fingers are of the compensating, self-aligning type. Easy operation is afforded by a flexible roller bearing in the top and a ball thrust-bearing in the base. Because of the latter the drum cylinder cannot settle. Several types of operating heads can be used.

A Pocket Pyrometer

An optical pyrometer that may be carried about in the pocket as easily as a rule, and which has no accessories and calls for no adjustment, being always ready for instant use, has been introduced by the Maco Template & Engineering Company, Ltd., 19 Cursitor St., London, England. This pyrometer may be used for obtaining the heat of molten metals, and the temperature of red-hot tools, as well as for controlling purposes, and is useful for all operations carried out at temperatures up to 1,200 deg. C. It is known as the "Pyroversum."

Wire Rope and Conditions of Use Have Both Improved

By A. J. Morgan
Assistant Wire Rope Engineer
John A. Roebling Sons Co., Trenton

WIRE ROPE has been called upon to perform increasingly severe service, not only on account of increased production in existing installations but also because of the tendency to pare down the design of new installations so that the first cost might be reduced.

Increase in production is obtained in several ways: increasing the loads handled; increasing the speed of operation; and operating the ropes more hours per day. Any one of these alone will reduce rope life. On existing installations, where the production is increased, the layout of the hoist is such that many desirable changes cannot be made to improve materially the conditions for more economical rope service. On new installations the tendency is to reduce the first cost, although to a greater extent it is recognized that more liberal design and more attention to the conditions governing wire-rope service are essential, and that such attention over a period of years results in real economy. A well-considered and proper decision on the points of design is of prime importance.

All of these changes have been going on, and it is gratifying, on checking up, to find that wire rope-service in general has not been reduced in the same degree as would be anticipated from the changes mentioned in the foregoing. A very particular reason can be given for this condition.

Continual improvement has been made not only in the quality of the wire rope, as manufactured, but also in the attention given to the wire rope by those in charge of the operations. Constant research insures the continued improvement of this product. The improvement in wire-rope manufacture has been gradual and continuous, and is all based on sound development, with no radical changes. This development has been along sound and tried engineering lines, and the results of the wire-rope service indicate the advantage gained.

Use of the proper quality of wire rope has had a marked influence. The attention to equipment on which wire rope is used, the method of handling it, and the careful lubrication and inspection given to the rope have also resulted in an increase in rope service, in spite of the increased requirements imposed upon it.

The importance of careful attention to the way in which wire rope is used has become impressed to a greater degree upon mine executives This has resulted not only in increased economy but also in the increased safety of all wire-rope operations. Many details which were overlooked previously and regarded as unimportant are now examined and taken care of regularly. The economic importance of this cannot be doubted.

Space is lacking to go into detail with respect to the many slight changes which can be made in sheave sizes and material and their position, all of which result in improved conditions for the wire rope. The details of wire-rope installations, the proper care of the rope, and the use of tried and approved attachments have all helped to make wire rope the safest structural and hoisting material available.

Study of wire rope and its uses is being recognized more and more as a specialty, and it is only natural that those concerns which specialize in it should have the more up-to-date and proper data for its use. Many more users are taking advantage of this service than ever before.

Many studies have been made by the various states in which hoisting apparatus is used, and this has resulted in safety codes, observation of which is compulsory in many cases. Most of the rules and regulations adopted are on the side of safety, as they should be.

To repeat, not only has wire rope itself been continually improved, but also the conditions under which it operates, and what is more important, a better understanding has been reached between the user and the manufacturer, which has developed mutual confidence, the result of which is beneficial.

NEWS OF THE WEEK

Summary

NEVADA'S quicksilver industry is shown by survey to be equipped to produce 10,000 flasks of the metal annually. Production in 1928 was less than 3,000. Two new mines join list of producers. Page 370.

* * *

Consolidated Mining & Smelting is negotiating for the purchase of a new copper-zinc discovery at Kimpkish Lake, which has created considerable excitement among mining men in British Columbia. Government report issued on the find. Page 369.

* * *

Noranda interests are reported to have secured a contract for refining blister from the Flin Flon smelter, now being constructed by Hudson Bay Mining & Smelting in northern Manitoba. Page 371.

* * *

Drill results at Roan Antelope, Mufulira and Chambishi are indications of what diamond drilling is showing in Northern Rhodesia. Maps and tables of exploration work at these three properties may be found on pages 372 and 373.

* * *

International Nickel has completed construction of the new 510-ft. chimney at its Copper Cliff smelter. This is the third highest of its kind in the world. Page 367.

* * *

Opposition to the proposed Mexican labor law by business interests continues practically unanimous. Genero P. Garcia, of the Mexican Mining Chamber, has issued a circular advancing objections to the law, which, he claims, may put many mines out of operation. Page 374.

* * *

McIntyre Porcupine is building a 100-ton test mill at its properties in the Porcupine district of northern Ontario, which may be the forerunner of a new plant to supersede the present 1,500-ton unit. New theories worked out by J. J. Denny are involved. Page 367.

Senate Committee Puts Manganese on Free List in Revising New Tariff Bill

Sliding Scale Adopted for Antimony—Tungsten Duty Reduced to 45c. per Pound on Metallic Content From 50c. Rate—No Changes Made in Schedules on Lead and Zinc Ore Imports

By Paul Wooton
Special Washington Correspondent

TRANSFER of manganese ore to the free list and the adoption of a sliding scale of duties on antimony, as regulus or metal, feature the metals schedule of the tariff bill as revised by the Republican members of the Senate Finance Committee. The wholesale price of antimony in the New York market is the basis of the proposed scale of duties, ranging from zero when the price is over 14c. per pound, to a maximum of 4c. per pound when the price is not more than 7c.

The metal schedule of the 1930 act shows an ad valorem equivalent lower than that of the 1922 act. This is based on 1928 imports. The schedule as it comes to the Senate is materially lower than in the House bill. The ad valorem equivalent is 34.76 per cent, as compared with 39.63 per cent in the House bill and 35.07 per cent in the present law.

Application of a sliding scale for antimony was proposed to the Reed subcommittee on the metals schedule by H. P. Henderson, of the Antimony Products Company, New York, as an alternative to a flat increase from 2 to 4c. per pound, which had been recommended to the Ways and Means Committee of the House. The maximum on the Henderson scale was 5c. No increase was made in the duty on antimony by the House committee. Mr. Henderson declared before the Senate committee that a 4c. duty would not increase the price of antimony metal.

To compensate for the elimination of the duty of 1c. per pound of manganese content on manganese ore, the duties on practically all iron and steel products have been made subject to a reduction of approximately 19.4c. per gross ton. The specific duty on the manganese content of manganese metal, manganese silicon, manganese boron, ferromanganese and spiegeleisen also was cut from 1⅞c. to 0.65c. per pound. The ad valorem rate of 15 per cent was not changed.

As is apparent, the Senate committee rejected the plea of the tungsten producers for greater tariff protection against alluvial tungsten from China by reducing the duty to 45c. per pound on the metallic tungsten content of tungsten ore. The House had increased the duty to 50c. Tungsten carbide powder is specifically included with other tungsten compounds at 60c. per pound on the tungsten content and 25 per cent ad valorem. The tungsten refiners sought an increase to 50 per cent in the ad valorem rate.

The House duty on silicon-aluminum alloys was reduced from 5 to 3½c. per pound, and ferrosilicon-aluminum alloys, which also carried a duty of 5c. in the House bill, were made dutiable at 25 per cent ad valorem. Ferrochromium containing 3 per cent or more of carbon takes a duty of 2½c. instead of 3½c. per pound, and the ad valorem duty on ferrochromium containing less than 3 per cent of carbon, and on chromium metal, was reduced from 30 to 25 per cent.

Tantalum is included in the provision made for barium and columbium in the House bill, with a duty of 25 per cent. The duty on cerium metal is cut from $2 to $1 per pound, and on ferrocerium and other cerium alloys from $2 per pound and 25 per cent ad valorem to $1 and 25 per cent ad valorem.

No changes were made by the Senate committee in the duties on lead-bearing and zinc-bearing ores, but the provision with respect to the latter stipulating that the duties shall not be applied to the zinc contained in lead or copper ores unless actually recovered has been stricken out. This provision was inserted in the bill by the House. The duty of 1½c. per pound imposed on zinc dross and zinc skimmings by the House bill was eliminated in the Senate draft.

Refusal of the Senate to accede to the request for increased duty on zinc-bearing ores is expected to result in considerable importations from Canada and Mexico. The committee was informed that this would mean construction of a smelter in the United States, just across the Canadian border, for the treatment of Canadian ore. A possibility also exists that an American plant may be built for the treatment of low-grade Mexican ores.

Nickel oxide, now dutiable at 1c. per pound, has been transferred to the free list. All alloys of chief value in tin, not specially provided for, have been placed on the free list with tin.

In response to pleas of the crucible manufacturers, the duty on amorphous graphite has been reduced from 10 to 5 per cent and on crystalline, lump, chip, or dust, from 25 to 20 per cent ad valorem. Mica splittings have been reduced from the House rate of 30 to 25 per cent, and waste, scrap, or ground mica from 20 to 5 per cent. Cut or trimmed mica takes a raise from 30 to 35 per cent. Pumice stone valued at $15 or less per ton steps down from 0.1c. to 0.05c. per pound, and over $15 per ton, from ¼c. to ⅛c. per pound; and wholly or partly manufactured pumice goes from 0.55c. to ¾c. per pound.

The rate on crude magnesite is increased from 7/16c. to 9/16c. per pound. Ground plaster rock or gypsum is raised from $1.40 to $3 per ton. Travertine stone, unhewn, decreases from 25c. to 15c. per cubic foot. The specific rate of ⅜c. per pound on unground talc, steatite, or soapstone is changed to 25 per cent ad valorem. Kieserite is put back on the free list, the House rate of ¼c. per pound being removed. Salt cake remains on the free list after considerable committee debate.

McIntyre Porcupine Plans New Milling Practice

McIntyre Porcupine will build a 100-ton mill at its properties in the Porcupine district of Ontario, to test the new milling methods evolved by J. J. Denny, mill superintendent. Tests will be carried on for six months. If, at the end of that time, the new method has demonstrated its superiority over the present flow sheet, a new and larger mill will probably be built to supplant the present 1,500-ton unit. No official statement can be obtained on the new process. Its advantages are reported to be substantial savings in power and equipment costs.

Goldfield Cons. Options California Placer Ground

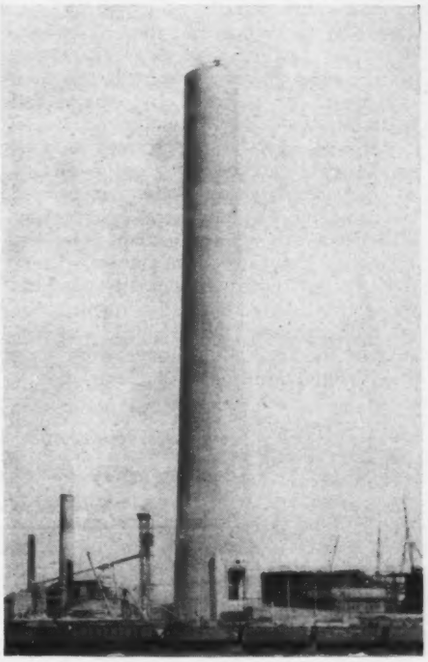
Goldfield Consolidated Mines Exploration Company, of Nevada, is reported to have optioned 1,400 acres of placer ground in Quartz Valley, Siskiyou County, Calif. The ground is being tested by churn drilling to determine if conditions are favorable for dredging.

Wilbert Develops 1,450 Level

Development at the Wilbert mine, near Arco, Butte County, Idaho, has been expedited by the connection of the 1,450 level with the main working shaft. Stoping of the South oreshoot has been started and a drift is being pushed ahead to cut the North shoot. Production, derived from these two orebodies on the 1,350 level, is being milled at the rate of 100 tons daily.

Inco Smelter Chimney, One of Highest in World, Completed

INTERNATIONAL Nickel Company of Canada has just completed the construction of a giant chimney, the highest in the British Empire and one of the highest in the world. The chimney stands today 510 ft. above its base, actually 560 ft. above the smelter yards at Copper Cliff, Ont. Its only competitors are the stacks of Anaconda Copper at Anaconda, Mont., of American Smelting & Refining at Tacoma, Wash., and of the Kuhara Mining Company in Japan.



The new chimney of International Nickel at Copper Cliff, which is 510 ft. high

The new International chimney was built by Custodis Canadian Chimney Company, Ltd. Eight different types of bricks are represented in its construction, each brick cut on radial lines to fit the circle and manufactured specially and prepared for this chimney by the Custodis company at Cooksville, Ont. Construction of the stack has required an estimated total of 4,500,000 bricks. The chimney has a dead weight of 16,000 tons. The first bricks were laid on April 22, 1929, and the chimney was completed, ready for inspection, with the exception of the lining, on Aug. 14.

Dimensions of the chimney are as follows: Outside diameter at the base, 72 ft. 7 in.; inside diameter at the base, 63 ft. 7 in.; outside diameter at the top, 48 ft.; inside diameter at the top, 45 ft. The chimney is entirely self-supporting and self-sustaining and rests on concrete foundation poured on bedrock. F. B. O'Connor was in charge of the 80 men employed on its construction. Thomas S. Clark, of New York, is president of Custodis Canadian Chimney Company, Ltd.

Government Would Reserve Minerals in Land Transfer

TRANSFER of all unreserved public lands from federal to state jurisdiction has been approved by President Hoover, according to a message transmitted to a conference of governors of public land states in Salt Lake City on Aug. 27, through J. M. Dixon, Assistant Secretary of the Interior. Mineral resources within these areas, however, will be retained as government reserves. The President points out that inasmuch as royalties from mineral lands revert to the Western states, either directly or through the Reclamation Fund, the reservation of these areas to federal control is not in the nature of a deprival. In his letter, the President emphasizes the point that abuse of permits for mineral development or unnecessary production and waste in our natural resource of minerals are matters of the deepest concern and must be vigorously prevented.

Bluebell Mines to Sink Shaft in New Program

THE Bluebell mine, at Riondel, B. C., on the east side of Kootenay Lake, has been taken over by Bluebell Mines, which is said to have been financed for a year's steady development. The mine was formerly one of the largest independent shippers in the province, first under ownership of a French syndicate and more recently under S. S. Fowler and B. L. Eastman, who are president and managing director, respectively, of the new company. It has been idle for two years.

Previous operations were confined to the Bluebell claim; the new owner will sink a shaft on the adjoining Comfort claim to develop an orebody about 400 ft. long and a width running up to 60 ft. No effort will be made to produce ore until the orebody has been fully developed, which, it is expected, will take about a year.

Berta Mining Head Is Arrested for Fraud

RICHARD E. PLUMBE, president, general manager, and purchasing agent of Berta Mining Company, recently indicted along with other officials of the company for fraud, was arrested on a fugitive warrant at his home in Denver, on Aug. 14. He was released under $2,500 bond, and will stand trial in El Paso, Tex.

Berta Mining owns 22 patented acres in the Morelos district, 52 miles northeast of Chihuahua City, Mexico. Average assay of ore was said to be 65 per cent lead and 8 oz. silver. It was reported that $750,000 of ore was on the dump and $1,250,000 opened up in the mine. On the strength of this, $200,000 was obtained from investors. Not more than 40 per cent of this was actually used for development, according to the complaint, the rest being pocketed by the officials.

Black Donald Graphite Operating New Hydro-Electric Plant and Concentrator

THE new hydro-electric installation of the Black Donald Graphite Company, of Calabogie, Ont., has been completed and is furnishing power for the concentrator at Mountain Shute, which is 2¼ miles from the company's mine. Calabogie is 50 miles west of Ottawa. The new plant replaces one that was damaged by the floods of 1928. Two 400-hp. General Electric generators, three transformers, and new turbines and governors, furnished by the William Hamilton Company, comprise the major units in the new plant.

The Black Donald mine has been in almost constant operation for the last thirty years, and has produced the largest part of the graphite mined in Canada during that period. The orebody is a massive deposit consisting essentially of exceptionally pure, fine-grained, flake graphite, inclosed in white, crystalline, Grenville limestones. It dips at a steep angle, and attains a maximum width of 70 ft. The average graphite content of the ore is 65 per cent, with local enrichments up to 80 per cent. Little of the flake is coarse enough to grade as crucible rock. The gangue consists chiefly of chlorite and calcite. The flake occurs disseminated in a matrix of granular graphite which is classed as "amorphous." It is estimated that about 25 per cent of the total mill output consists of flake grades, the remainder being amorphous and dust products. No attempt is made to produce crucible graphite, the output consisting of high-grade, lubricating and electrotyping flake, and foundry, grease, stove-polish, and core-wash graphites.

The ore is hoisted from the mine through a 350-ft. vertical shaft and is fed to a 12x20-in. Buchanan rock crusher. From the crusher it is conveyed about 450 ft. to the ore dump back of the mill, whence it passes to a Universal rock crusher that reduces the ore to about 1½ in. and discharges it into a mill storage bin. From this bin the ore is fed by automatic feeders into a battery of 850-lb. California stamps, furnished by the Canadian Allis-Chalmers Company. The discharge from the battery passes to a 12-mesh trommel, the oversize of which is known as product No. 17 and is concentrated on tables. From the time the graphite is fed into the stamps it is handled by water in screw conveyors or drags. The undersize from the trommel is conveyed to Callow flotation cells, where, with the aid of creosote, kerosene, and pine oil reagents, the graphite is floated. Air for the flotation cells is supplied by a Roots blower.

On the first floor of the mill are the flotation cells, blower, settling tank, filter press, and the driers. This equipment is powered by a 75-hp. Canadian General Electric motor. The units on the second and third floors, which comprise the bagging bins, stones, and bolting reels, are operated by a second motor of the same capacity and manufacture. If either motor fails, the other will operate the entire plant.

Concentrate from the flotation cells is conveyed by a drag elevator to revolving steam driers which remove all oil and moisture. From the driers the graphite concentrate is lifted by elevators to upper floors of the mill, where it is first further refined by successive bolting through revolving reels and then is ground or polished by emery and buhrstones.

All reels and bolting screws as well as bagging and other equipment of wooden construction were constructed by company carpenters. The rotating oil-burner drier was furnished by the Harmon Company; the steam driers were reconstructed in company machine shops from driers used in a former mill of the company which mill was destroyed by fire. Buhrstones were supplied by the Munson Mill Company.

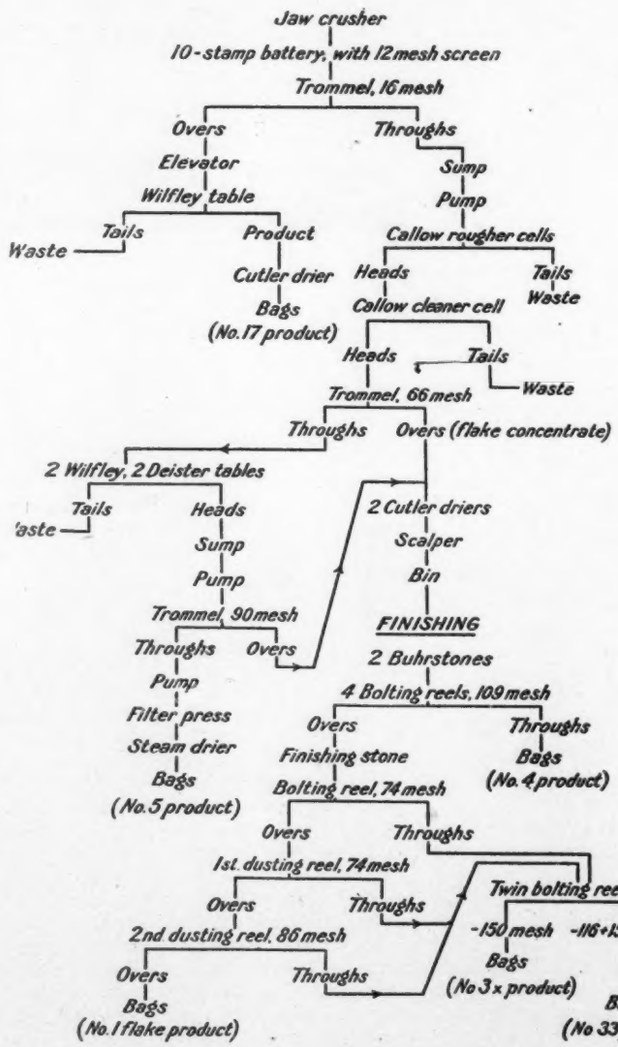
Treasure Vault Mining Takes Over Pilgrim Mine

Treasure Vault Mining has taken over the Pilgrim mine, 9 miles west of Chloride, Mohave County, Ariz. Not long ago a 5-ft. vein of gold ore averaging $25 per ton was reported to have been discovered on the 230 level of this mine. Pilgrim took first prize a few weeks ago for the best display of gold ore at the Prescott Northern Arizona fair.

The new management plans to stope the vein on the 230 level and to crosscut to it on the 350 level. A 25-ton pilot mill is on the property. M. B. Dudley is president of Treasure Vault.

Humboldt Sulphur Resumes

Humboldt Sulphur, at Sulphur, Nev., has resumed operation and is producing about 25 tons of sulphur per day by flotation. An excellent extraction is being secured from the raw material mined from its open pit. Exploratory drilling of the sulphur deposits is in progress, and seven or eight holes have been churn drilled to a depth of 100 ft. in the deposit.



Flow sheet of the Black Donald graphite concentrator

New Unit at Walker Starts Operation

THE new unit of Walker Mining near Spring Garden, Plumas County, Calif., went into commission on Aug. 20. Addition of new flotation and crushing equipment increases the capacity of the plant from 1,200 to 1,600 tons of ore daily.

A.I.M.E. to Participate in National Metals Week

AMONG the societies whose meetings are being held in Cleveland as part of National Metals Week, on Sept. 9-13, will be the Institute of Metals and the Iron and Steel Division of the A.I.M.E. The feature of the week is the National Metal Exposition, held in the Cleveland Public Auditorium. The other societies co-operating in this first national metal congress, reviewing the achievements of the past year in all the metal industries, are the American Society for Steel Treating, the American Welding Society, and the Iron and Steel Division of the American Institute of Mechanical Engineers.

The sessions of the A.I.M.E. divisions will be held at the Hotel Cleveland and the Public Auditorium. Registration is at both places on Monday, Sept. 9.

Numerous plant inspections have been arranged throughout the week for members of all societies, in addition to technical meetings on Sept. 10-12.

Walkover Changes to Cyanide

A Hardinge conical ball mill, a rake classifier, and a low-pressure compressor are being installed in the mill at the Walkover mine, near Hackberry, Ariz. When this work is done the mill will be operated as a cyanide plant entirely and the amalgamation units will be discontinued.

Carlotta Copper Formed

Carlotta Copper has been formed to acquire the Alexander properties in the Pinto Creek district of Arizona, near Miami. Walter A. RuKeyser, mining engineer, of New York, is president of the new company. Shipments of siliceous copper ore are now being made to the Magma, El Paso, and other smelters.

Alta Tunnel Shipping

Shipments have started from two new strikes made in the Alta Tunnel mine, in the Park City district of Utah, one above the main tunnel level and the other 700 ft. above and far to the north, in the Prince of Wales fissure system, from which the Walker brothers took a million dollars sixty years ago. High-grade silver-lead ore from this horizon is being shipped direct to the smelter, and that from the lower horizon is being treated in the mill. Lloyd Hoskins is in charge at the mine.

Consolidated M. & S. May Buy Kimpkish Lake Claims

THE NEW copper-zinc discovery near Kimpkish Lake, in the northern part of Vancouver Island, has created considerable excitement among mining men, who consider it to be the outstanding discovery of recent years in British Columbia. Engineers of Consolidated Mining & Smelting have made examinations of the property, which comprises about 200 mineral claims, and, subject to the approval of the directors of the company, arrangement has been made for acquiring control of the property at a figure that will surpass any mining transaction made in British Columbia for many years.

The following account of the property is by George Clothier, government mining engineer for the southeastern mineral survey district, and has been issued by the Provincial Minister of Mines, bearing the seal, therefore, of government approval:

"An extraordinary amount of stripping and open-cutting has been done, disclosing some remarkable surface showings of ore, ranging from straight chalcopyrite to straight sphalerite. The ore occurs in a contact belt of altered greenstone up to 200 ft. or more in width, lying between the main granite range on the west and the greenstone and limestone to the east. The strike of the contact is irregular, but in general is about north 70 to 75 deg. west (magnetic) and the dip is 80 to 85 deg. east with the slope of the hill. Ore has been exposed in four places within a length of 3,000 ft., showing the mineralization to extend across a width of more than 100 ft., in which are masses of chalcopyrite 10 to 15 ft. wide. The farthest north showing is stripped for a width of 60 ft. and on the north end at one point there is a width of 25 ft. of practically solid chalcopyrite, the remainder showing ore in which limestone is embedded. This stripping is about 100 ft. along the lode, but has been made for a width of only about 30 ft. at the south end, where similar massive bodies of chalcopyrite have been exposed, but cut by two small cross-dikes. About 2,500 ft. to the south of this, two other large strippings have exposed the mineralization across a width of 70 to 90 ft., showing widths of 10 to 15 ft. of chalcopyrite. At one place lower down the hill and in the limestone a showing of sphalerite 15 to 20 ft. wide has been exposed. Below the cabin, on the edge of a deep canyon, another cut has been made, exposing a width of more than 20 ft. of chalcopyrite. This is probably a parallel belt to the upper one and has not been traced out as yet. Altogether it is a remarkable showing, and, should it maintain its surface proportions and mineralization, will produce an immense tonnage for every 100 ft. of depth obtained."

Lavena Group Changes Hands

John L. Templeman, formerly chief counsel of the W. A. Clark interests, has sold the Lavena group, in the northwestern part of Butte, to Larry Duggan and George Bennett. Mr. Templeman, in prospecting the property to the 200 level, shipped several cars of silver-gold ore. The new owners are stoping on the 200 level.

Louise Explores Fissures

Two faces are being driven by Louise Mining in the southern extension of the Cardiff overthrust contact at Alta, Utah, to explore a series of northeast-southwest fissures which on the surface have produced considerable high-grade ore.

Mass Production Tycoon Purchases Gold Mine

SMALL-SCALE gold miners should not be over-confident at the news that Henry Ford, the well-known mass production manufacturer, has entered their field, with the purchase of the Vaucluse mine, in Orange County, Va. The price was reported at $10,000. It is, however, doubtful whether the mine, abandoned since the Civil War, will be subjected to modern mining. It is rather believed that Mr. Ford purchased the property as part of his program of preserving historic landmarks.

The Vaucluse mine was discovered in 1832, and operated profitably until flooding and leanness of ore caused a halt. Many battles were fought in this neighborhood during the Wilderness engagements of the Civil War.

Banfield Mill Ready Soon

CONSTRUCTION of a new 50-ton flotation plant at the Banfield Mining property, near Drew, Douglas County, Ore., is now almost complete, and operations will probably be started soon. Ore at this property is mostly chalcopyrite. Development work has disclosed the presence of high-grade ore in a coarsely brecciated zone, which also contains considerable mill-grade material.

Diamond drilling is planned in the near future to guide additional development work with the idea of opening up reserves large enough to justify construction of a much larger plant, according to P. R. Whitman, superintendent of the company. Although the former operators realized that the Banfield ore was rich, they supposed it to be pockety and hard to trace, so that development up to the present has been limited in extent.

Nevada's Quicksilver Industry Established in Eighteen Months

Eight Rotary Furnaces and One Hearth Furnace Now in Operation With a Combined Productive Capacity of 900 Flasks Monthly —Castle Peak and Mina Mercury Latest Additions to List

By C. F. SPILMAN
Nevada Correspondent

NEVADA'S quicksilver industry, now equipped to produce more than 900 flasks of the metal a month, has grown to its present proportions within the last eighteen months. Eight furnaces of the rotary type and one Herreshoff hearth furnace are now in operation, with the completion of the plants of Castle Peak Quicksilver, in Storey County, 19 miles northeast of Reno, and Mina Mercury, in Mineral County. Assuming a production of about, 10,000 flasks of quicksilver annually—which at current quotations would be worth about $1,500,000—Nevada would undoubtedly take first place among the quicksilver-producing states. Last year, the state produced 2,905 flasks, as compared with 6,711 flasks produced by California, which led the nation in this respect. In 1927, Nevada produced only 425 flasks.

The Castle Peak plant, which was completed and put in operation Aug. 24, is a fair example of the accomplishments of recent years in metallurgical practice in the treatment of cinnabar ores. The entire plant with the exception of electric power and water lines was designed and installed by H. W. Gould & Company, of San Francisco. Gould & Company contracted to erect the plant and operate it for thirty days.

The furnace is a Gould improved quicksilver furnace of the rotary type, 3x40 ft. in dimensions, with oil feed, built by the Mutual Engineering Company, South San Francisco, with Gould ore feeder, dust chamber, and condensing system. The plant was installed by C. W. Washabaugh, construction engineer for H. W. Gould & Company, and is being operated by R. L. Brown, another member of the company's engineering staff.

Castle Peak Quicksilver has been developing its mine since April, 1928, and has 50,000 tons of developed ore averaging 12 lb. of mercury per ton. In addition there is some 6-lb. ore, opened in raises from the main working adit, but not blocked out. On an operating basis of 40 tons a day, production will be 150 flasks a month. The ore is a kaolinized andesite in a shear zone following the lines of a fault plane. The mineralized zone has been opened for a length of 150 ft. and a width of 50 ft., with a maximum thickness of 85 ft., but ore has been found 300 ft. beyond this developed section of the mine.

Castle Peak's property is in Storey County, about six miles north of Virginia City. It was acquired by H. E. Loufek, of Reno, by purchase and location, late in 1927. After exploring the surface by trenching and opening the ore through a tunnel, Mr. Loufek interested acquaintances from Davenport, Iowa, who financed the development and equipment of the mine. Mr. Loufek is president of the company and general manager. The Iowa stockholders are represented by Dr. P. A. Bendixen and B. T. Dow, of Davenport. C. N. Shaffer is mine superintendent and Arthur Schumaker will have charge of the furnace. A power line 4½ miles long from the Virginia City line of the Sierra Pacific Power Company supplies power.

This article on current operations in the quicksilver districts of Nevada is the first of a series of résumés of operations in mining districts that will hereafter appear regularly in the news columns of "E.&M.J." These résumés will serve to supplement our regular news service and should present to the reader a more accurate picture of conditions in the various mining districts than is possible through the occasional and rather unrelated items that would otherwise appear.

The Mina Mercury property was first worked in 1907 and has been operated since at intervals, principally by lessees, who treated the higher grade ore in retorts. E. W. Bedford, the present manager, reports 30,000 tons of 14-lb. ore developed in the mine. Mr. Bedford, R. H. Gunnell, of Silver City, N. M., and B. F. Miller, Jr., a Los Angeles real-estate man, have a lease on the property with option to purchase. Gunnell was the discoverer of the Ground Hog mine, control of which he sold to American Smelting & Refining.

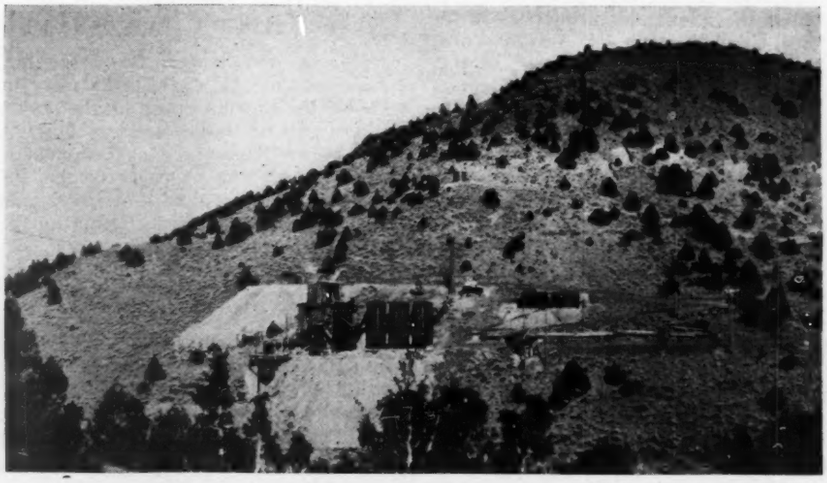
Mina Mercury is building a plant identical in design with the Castle Peak plant, except that the furnace, built by the Cottrell Engineering Company, of Los Angeles, is 3x25 ft. Power will be supplied by a Fairbanks-Morse semi-Diesel engine. The furnace will be started before the end of August.

The B. & B. Quick property is at the north end of the White Mountains, western Esmeralda County, and is connected with the Owens Valley branch of the Southern Pacific Railroad at Basalt, near Mount Montgomery pass. In this property the ore is a hot-water deposit, in sandstone and opalite, and averages 6 lb. per ton. The rotary furnace, designed by the Cottrell Engineering Company, treats 60 tons a day, with an average output of six flasks. Total production to date is 1,400 flasks. The ore is mined by the glory-hole method and transported down hill to the furnace. Power is supplied by Fairbanks-Morse Diesel engines.

At Arlemont, 4 miles from the B. & B. mine, a small 15-ton rotary furnace of Cottrell design has been installed at the Good & McKinney mine and is producing at the rate of 60 flasks a month. The ore occurs in limestone and is of high average grade. The furnace is now operating on rejects after sorting out high-grade for retorts, which were used for the first year of operation.

Three furnaces are operating in the Antelope Springs district, Pershing County, 25 miles east of Lovelock. The Pershing Quicksilver Company put in

General view of workings of Castle Peak Quicksilver



Looking southeast from water tower at the main shaft of Sherritt-Gordon, in northern Manitoba

the first rotary furnace to be installed in Nevada, and recently added a Herreshoff hearth furnace to treat fine ore, having experienced trouble with dust from the fines in the rotary. The two furnaces handle about 135 tons a day. Production has not been given out, but is said to be around 600 flasks a month.

In this mine the ore is found along a lime-shale contact and in the limestone. The larger deposits are at the junction with cross-fractures. The mine has been developed for about 2,000 ft. through four tunnels. Electric power is supplied for this mine and Nevada Quicksilver, 2½ miles north, by the Nevada Valleys Power Company.

The first Gould rotary furnace in Nevada was installed last year by Nevada Quicksilver, of which L. A. Friedman, Lovelock mine operator and banker, is president. It consists of a 3x40-ft. furnace with Cyclone dust chamber and Monel-metal condensing system, and has a capacity of 35 to 40 tons a day. The plant started operations on Sept. 5, 1928, running on high-grade ore, ranging from 30 to 60 lb. per ton, and the mine became a veritable sensation. Production ran as high as 38 flasks in a single day. Production in October was 20 flasks a day, a flask for each ton of ore put through the furnace. From Sept. 5, 1928, to March 31, 1929, production was 2,093 flasks of 76 lb. At that date 1,870 flasks had been shipped, bringing a net return of $212,394; 260 flasks were in transit, and 23 flasks on hand.

The property is on the same lime-shale contact as the Pershing, but the richest ore is found in fissures in the limestone. The mine is opened by an incline shaft in the footwall, which has been sunk 500 ft. Mine equipment consists of an electric hoist, air compressor, and a full complement of tools.

A duplicate of the Nevada Quicksilver plant has been installed at the property of Nevada-Mexico Mining at Beowawe, Lander County. The ore so far developed in this mine is of low grade and production has been small. Power is supplied by Fairbanks-Morse Diesel engines. Promising prospects are being developed at Antelope Springs and in Dunlap canyon, southwest of the Mina Mercury mine. Cinnabar King Mining has opened high-grade ore in Spring Valley, about six miles north of Antelope Springs, and makes an occasional run of ore in Scott furnaces. The old-style D retort is still in use where very high-grade ore is found, but these operations are irregular.

Rico Argentine Resumes Shipments to Smelter

ORE from the Rico Argentine mine, at Rico, Colo., is being moved via Alamosa to Salt Lake City. The first ore to be received in several months since the Ames slide, west of Ophir, covered the Rico branch of the Denver & Rio Grande Western railroad, arrived on Aug. 10 at the Midvale smelter.

Development is being carried on in three levels. The Flame level, being projected to cut the twelve known ore horizons, has cut three new horizons, all of which carry ore. To date, Rico Argentine production has come from only five of the known beds, ranging from zero to No. 4.

Mount Morgan Mine Resumes Operations

THE once-famous Mount Morgan mine, in Queensland, Australia, has been sold for £70,000 by liquidators of Mount Morgan Gold Mining. The new owners have started operations.

When production was discontinued, in 1927, estimated ore reserves were 8,000,000 tons. Of this, 700,000 tons is actually in sight and will be attacked immediately by open-cut methods. When the old company was operating, E. E. Barker, of Utah Copper, was employed as consultant, and gave the opinion that open-cut mining was not practicable. While concentrating on production, a development program is planned.

Noranda to Refine Flin Flon Blister Copper

AN agreement has been reached under which the blister copper output of the Flin Flon smelter, now under construction by Hudson Bay Mining & Smelting in northern Manitoba, will be refined at the electrolytic plant to be erected by the Noranda interests in eastern Canada. The Flin Flon smelter is expected to be in operation by 1931, when it will be producing 30,000,000 lb. of blister copper annually from the Flin Flon mine, according to official estimates. It will also smelt the output of Sherritt-Gordon Mines, which is being equipped to treat 1,500 tons of ore daily, and should have an annual production of about 20,000,000 lb. of copper.

The refinery will be operated by Canadian Copper Refiners, Ltd., controlled by Noranda Mines, Ltd. No announcement has been made of details of construction or of location, but it is expected to be in Quebec, on the north shore of the St. Lawrence River, convenient to the Noranda smelter in the Rouyn district and to markets of the metal. Construction will be started this fall.

Associated with Noranda in Canadian Copper Refiners are British Metals Corporation, Ltd., which owns the Tetrault and Stirling mines, and Nichols Copper, which operates the old Laurel Hill refinery and is erecting a large refinery at El Paso, Tex.

The forthcoming annual report of Sheritt-Gordon Mines is expected to contain an official estimate of ore reserves. The report will be sent out to shareholders within the next sixty days. Three shafts have been started within the last year. Work from what is now known as the central shaft is well advanced at the 375 level. Operations have been under way for some time from the 250 level of the east shaft. The new western shaft has been driven to a depth of about 125 ft. Nearly 17,000 ft. of underground work has been carried out. Through this work an ore length of close to 2 miles has been determined. The grade and amount of ore being placed in sight through the underground development is more than meeting expectations aroused through diamond drilling. The two extreme shafts are separated by about 10,000 ft. Ore may be found throughout the entire 10,000 ft.

Kennedy Begins Excavation for Underground Shaft

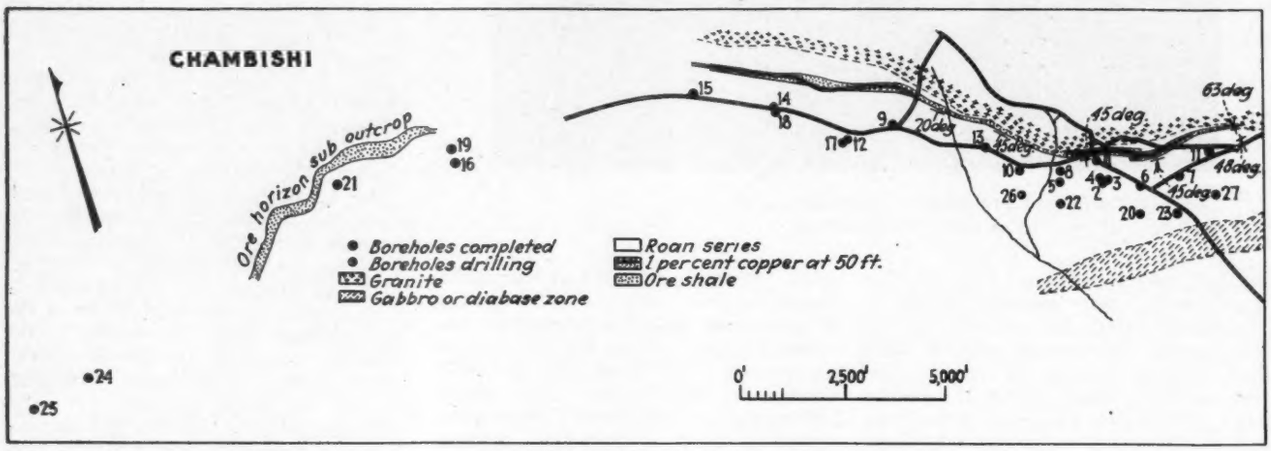
Kennedy Mining & Milling, at Jackson, Calif., has started excavation of an underground shaft from the 4,650 level. It will follow the vein at an angle of 65 deg. The new shaft will be of three compartments, with transfer pockets.

Excavation for stations and pockets will be in the footwall west of the vein. On the surface an electrically operated boom hoist for handling mine timbers has been erected. The mast is 75 ft. in height. the boom 67 ft., and the load from five to six tons.

What Diamond Drilling Is Showing in Africa

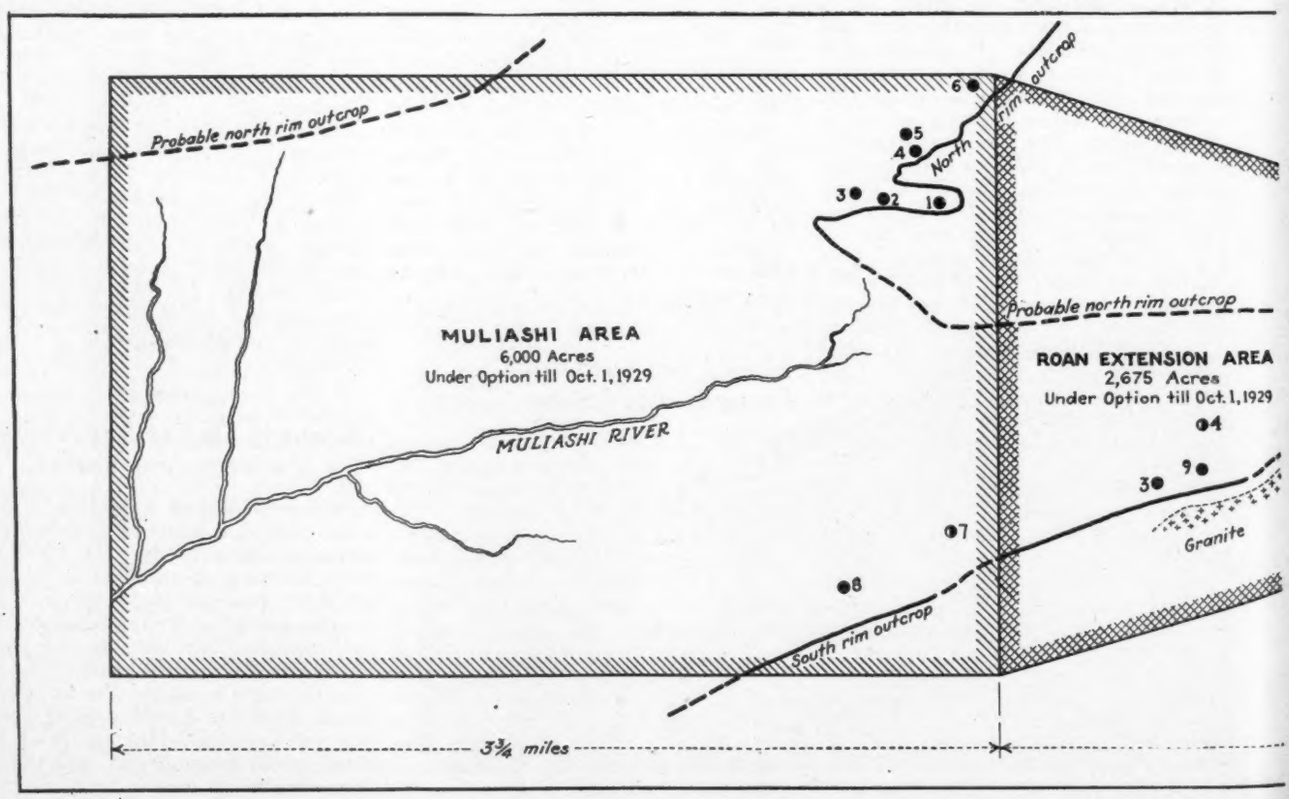
NORTHERN RHODESIA forges to the front as the world's next great copper region. In three years the progress made in proving the extent of commercial deposits has been astonishing. Drill after drill has disclosed the presence of ore—not high grade, as a rule, but by no means low grade on the average. Several mines that were unknown a few years ago are now considered as promising an output of copper as large as any in the field; and the exploration for minerals in Rhodesia has only begun, so to speak.

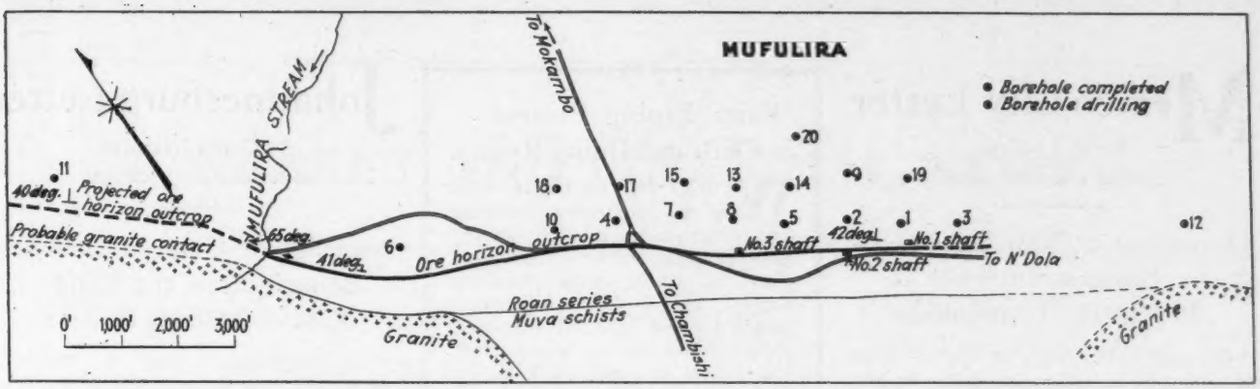
A series of articles, dealing mainly with the N'Kana Concession but covering all the important deposits, written by Dr. Anton Gray and Mr. R. T. Parker, chief geologist and manager, respectively, for Rhodesian Selection Trust, are scheduled to appear in forthcoming issues of *Engineering and Mining Journal.*



Chambishi Drilling Results

Hole No.	From Ft.	To Ft.	True Width, Ft.	Per Cent Cu
1	185.00	215.00	27.00	3.50
2	Lost at 291 ft.			
3	Lost at 240 ft.			
4	375.00	403.00	25.00	4.27
5	Lost at 505 ft.			
6	386.00	475.00	77.00	2.99
	386.00	439.00	46.00	2.06
	439.00	475.00	31.00	4.37
7	406.00	417.20	9.80	3.85
8	279.00	321.00	28.00	2.73
9	360.60	375.60	14.40	2.36
10	420.00	448.20	25.40	0.56
11	Granite a	220 ft.		
12	Lost at 395 ft.			
13	397.00	415.80	.....	2.02
14	Lost at 318 ft.			
15	322.00	382.60	.....	0.25
16	Lost at 190 ft.			
17	693.10	705.20	10.64	2.98
18	496.60	513.80	.....	1.22
19	340.40	365.20	.....	0.41
	380.50	395.00	.....	0.49
	637.40	687.80	.....	1.80
20	687.80	713.50	.....	5.77
	637.40	713.50	.....	3.14
21	Stopped at 445.5 ft. No ore.			
22	690.40	705.30	13.8 (?)	1.74
	705.30	728.00	21.00(?)	3.04
	728.00	748.20	18.80(?)	3.65
	690.40	748.20	53.60(?)	2.92
23	687.75	705.50	16.00(?)	2.70
	705.50	719.75	13.25(?)	1.12
	719.75	749.60	27.75(?)	5.13
	687.75	749.60	57.00(?)	3.51
24	Stopped at 433 ft. No ore.			
26	Stopped at 978 ft. No ore.			
27	584.55	594.30	6.9	4.59





Mufulira Drilling Results

Hole No.	From Ft.	To Ft.	True Width, Ft.	Total Cu, Per Cent
1	291.50	312.20	15.30	9.49
	391.00	422.75	23.80	5.72
	491.00	512.00	15.70	5.14
Total			54.80	6.61
2	357.00	374.24	12.60	8.62
	453.90	474.00	15.40	4.21
	532.00	568.40	26.57	4.91
Total			54.57	5.57
3	Stopped at 701 ft.		No ore.	
4	350.00	First horizon practically not mineralised.		
	405.00	Second horizon mineralization slight.		
	472.00	530.00	44.43	5.75
5	337.00	363.80	20.53	5.47
	429.83	471.00	31.53	6.93
	506.00	549.00	27.63	5.28
Total			79.69	5.98
6	Stopped at 615 ft.		No ore.	
7	358.00	370.00	10.40	2.83
	416.00	508.00	78.90	4.78
Total			89.30	4.55
8	336.00	365.00	22.30	4.82
	432.00	466.50	26.80	4.98
	493.80	554.00	47.50	4.32
Total			96.60	4.62
9	941.25	950.97	7.00	5.43
	1039.80	1068.60	21.00	7.32
	1122.00	1169.00	35.00	4.14
Total			63.00	5.35
10	437.83	469.03	....	2.87
11	497.49	503.70	....	2.03
12	Stopped at 660 ft.		No ore.	
13	883.70	944.00	40.60	3.59
	999.03	1075.50	48.00	4.29
	1095.00	1195.20	59.00	4.00
Total			147.60	3.85
14	893.42	929.57	26.50	6.71
	1007.18	1055.00	35.00	5.70
	1094.90	1159.70	47.00	5.37
Total			108.50	5.80
15	885.00	904.63	.....	1.90
	961.00	1070.30	.....	3.44

Roan Antelope Drilling Results

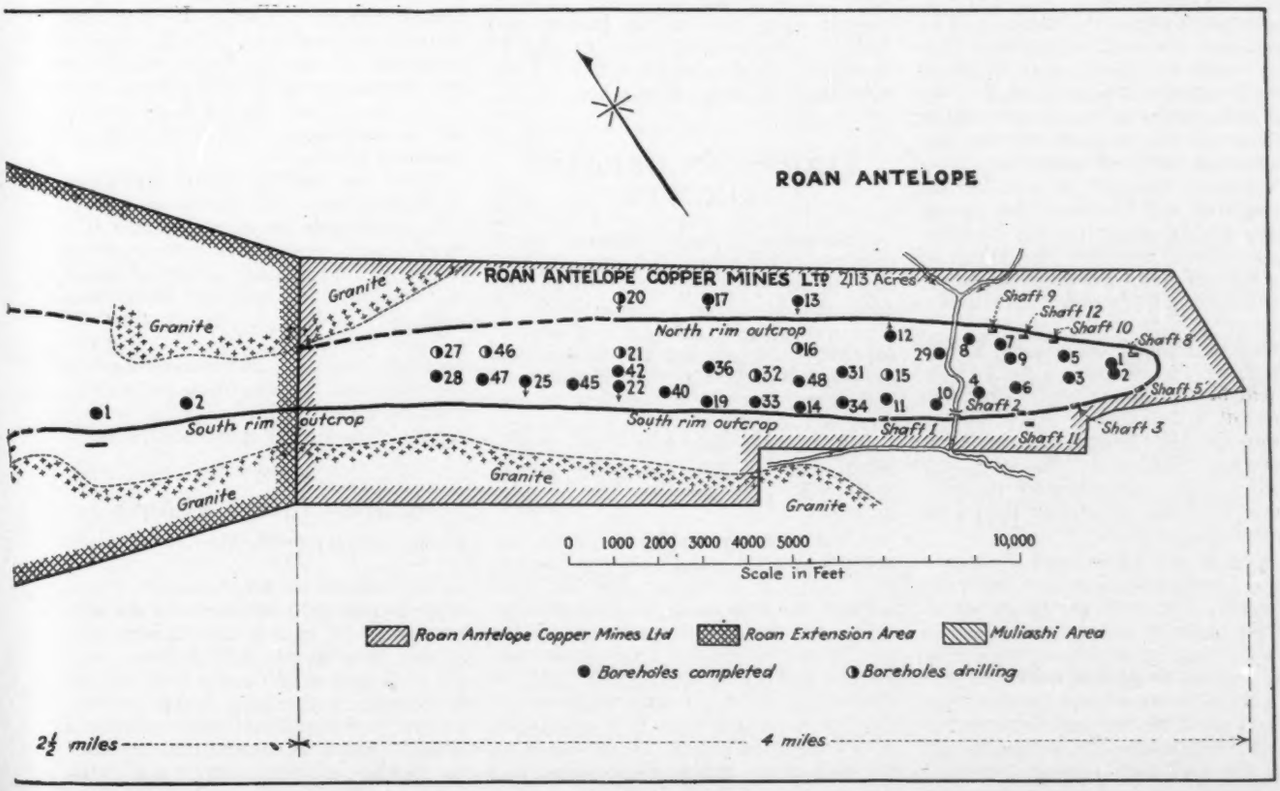
Hole No.	From Ft.	To Ft.	True Width, Ft.	Total Cu. Per Cent
1	457.75	497.50	36.5	3.87
2	341.25	376.50	27.5	3.40
3	526.00	573.00	36.5	4.00
4	671.00	705.00	26.8	2.81
or	671.00	693.00	18.0	3.40
5	514.00	555.00	38.0	4.15
6	616.00	650.00	30.0	3.80
7	596.00	634.00	31.5	2.60
or	596.00	608.00	10.0	3.00
	608.00	626.00	15.0	2.00
	626.00	634.00	6.5	3.15
8	440.00	472.00	28.5	2.64
or	440.00	448.00	7.5	3.72
	448.00	460.00	10.5	1.38
	460.00	472.00	10.5	3.22
9	1003.00	1055.00	47.1	3.65
or	1003.00	1053.00	45.0	3.70
10	621.00	645.00	16.5	3.18
or	623.00	643.00	14.0	3.30
11	847.00	869.00	14.5	3.17
12	700.00	727.50	24.5	3.24
13	605.70	628.00	17.30	3.13
14	496.00	530.00	11.60	3.69
17	551.00	563.00	11.00	2.70
19	667.00	686.00	9.50	3.46
22	734.00	751.00	16.10	3.28
25	647.70	689.90	21.10	3.75
28	648.00	663.00	14.80	3.36
29	1396.33	1420.00	21.25	2.82
31	1743.00		20.50	3.15
33	588.30	612.60	10.30	3.81
34	736.00	756.33	13.10	3.22
36	1845.00		13.30	3.46
40	531.30	551.80	10.25	3.78
42	1679.70	1697.00	11.80	4.04
45	677.20	710.20	14.58	4.74
47	590.60	622.60	18.60	3.71
48	1723.00	1742.00	15.60	3.16

Roan Extension Area

Hole No.	From Ft.	To Ft.	True Width, Ft.	Total Cu. Per Cent
1	613.50	655.50	27.0	2.93
2	512.60	538.00	24.2	3.04
3	391.50	432.50	26.9	2.71
4	449.40	481.50	22.7	5.21
9	555.70	598.70	32.2	3.49

Muliashi Area

Hole No.	From Ft.	To Ft.	True Width, Ft.	Total Cu. Per Cent
1	165.00	208.00	40.0	1.90
2	284.00	335.00	32.5	3.00
3	Stopped at 800 ft.		No ore.	
4	199.00	222.00		2.19
	285.00	306.00		1.94
5	Stopped at 798 ft.		No ore.	
6	265.00	282.50		3.15
	462.00	490.00		2.64
8	434.75	461.50	24.98	3.20



Mexico City Letter

By W. L. Vail
Special Correspondent

Opposition to New Labor Law by Business Interests Is Practically Unanimous

Mexico City, Aug. 23, 1929.—After passing a Constitutional amendment permitting passage of a national labor law, the special session of the Mexican Congress has convened. The necessary majority of the states has sanctioned the amendment, and discussion of the law will start at the regular session of Congress next month. Business interests are practically unanimously of the opinion that the new law will mean commercial suicide. Genero P. Garcia, president of the Mexican Mining Chamber, issued an exhaustive circular on Aug. 15 dealing with the effect that the law, in its present form, would have on the mining industry.

Cost of producing at Mexican metal mines, he estimates, would be increased 13 per cent by the new law. Some time ago the same organization issued a statement showing that under present conditions Mexican mines are operating on a margin of from 2 to 3 per cent. Shortening working hours, establishment of a minimum wage, arbitrary obligation to construct homes for workmen, and constant interference by government inspectors are some of the items mentioned as unnecessarily increasing expenditures.

According to the law, Mexico will be divided into ten judicial districts, each with a board of arbitration to which all labor difficulties will be submitted. This board will consist of one representative of labor, one representative of the employers, and one representative of the government. Passage of the law as contemplated will result in the closing of many mining properties, the Chamber expects, which are now operating on low-grade ore. Several thousand laborers would thus be thrown into unemployment.

Taxes paid under compulsion to the revolutionary forces during the last revolt will be considered legal, President Portes Gil has declared. According to international law, foreign individuals or corporations could not be forced to pay the taxes again, and therefore the government felt that Mexicans should be allowed exemption also.

Closing of the Chontalpan y Anexas mine, at Chontalpan, Guerrero, has been indefinitely postponed as the result of the strike of a new mineralized zone. In 1926, this property, which carries chiefly silver ore, was thought to have only one year's reserves, but enough ore has been found from time to time to keep the mine in operation. The company also owns the Xitinga mines, where a cyanide plant has been put in operation.

Water Piping Project in Chilean Mining Region

Work will be begun soon on an important construction program intended to supply the Tocopilla nitrate mining region, in Chile, with drinking water. Pipes, 240 kilometers long, will be laid to transport about 15,000 tons of water daily. The source of supply will be the Andean ranges near the Bolivian border, where they are about 4,100 ft. high. The cost is estimated at 38,000,000 pesos.

Santa Gertrudis Develops Don Carlos Vein Further

Development on the No. 22 level of the Don Carlos group, the property of Santa Gertrudis, in the State of Hidalgo, Mexico, has further opened up the Don Carlos vein. A total of 512 ft. has been driven on this level, of which 246 ft. was in good-grade ore for a width of 7.8 ft., and the remainder in junore. A southeast crosscut was driven on the vein east of the fault, and 131 ft. of ore with a width of 9.9 ft. has been opened.

On levels 19 and 20, some low-grade ore has been opened. Exploration for the western extension of the Don Carlos vein on the 16th level has been suspended. Other drifting on this level is in progress. During the three months ended on June 30, a total of 8,593 ft. of development work was driven in the Don Carlos group, of which 1,284 ft. was in ore, 1,430 ft. in junore, and 5,879 ft. in country rock. At the El Bordo and Malinche mines limited development is being undertaken.

RHODESIAN DRILLING RESULTS

Rhodesian Congo Border Concession reports that drill hole N.E. 7 has cut ore at a depth of 830 ft. and continued in ore to a depth of 890 ft. The ore averaged 5.36 per cent copper, of which 1.79 per cent was in the form of sulphide and the rest cuprite and malachite. Dip of the lode was 26 deg. from depth of 830 to 850 ft.; locally contorted and dips obscured, from 850 to 880 ft.; and 34 deg. from 880 to 890 ft. Hole N.E. 7 is 2,400 ft. west of hole N.E. 6.

N'Changa Copper Mines, Ltd., reports that drill hole B. 20 has cut ore at a depth of 1,110 ft. The ore from 1,100 to 1,260 ft. averaged 3.80 per cent copper, of which 1.93 per cent was in the form of sulphide. Dip of the lode for the top 115 ft. was 75 deg. and for the bottom 35 ft., 16 deg. Hole B. 20 is 2,600 ft. west of hole B. 19 and 1,200 ft. northwest of hole B. 17, as shown on the map on p. 153 of *Engineering and Mining Journal* for July 27.

Johannesburg Letter

By Owen Letcher
Special Correspondent

Shortage of Colored Labor Is Being Felt on the Rand—Talk of Mining Radium

Johannesburg, July 9, 1929 — Efforts on the Witwatersrand are now being concentrated on maintaining tonnage, or replacing manual labor by mechanical appliances wherever possible, on improving labor efficiency, and on obtaining further supplies of "boys" from every corner of the Union to try to counteract the falling off in the number of workers from Portuguese East Africa which is one direct result of the new Mozambique Convention. Contraction in profits of the Rand mines for the first six months of this year as compared with those for the corresponding period of 1928 shows that scarcity of colored labor is having its effects.

Cape Town geologists are confessedly perplexed over a report that an American philanthropist has bought 200,000 acres in Southwest Africa with the idea of producing radium and lowering the price. "I have never seen a specimen of radio-active ore from Southwest Africa," said a leading geologist. "There are deposits of pitchblende, however, at Gordonia, which is close to the border, and there is no reason why this geological structure should not be continued over the border in the Warmbad district of Southwest Africa. Sample shipments of the Gordonia pitchblende first discovered in 1925 have been made to Europe. Last May it was reported that developments on a large scale are expected shortly."

There has been no actual production of radium from the Gordonia district. The pitchblende mines are located in a lonely and mountainous area where transport difficulties are great. Samples of Gordonia pitchblende have been analyzed, and it is stated that the radium content of the ore compares favorably with the radio-active ores of Chinkolobwe, in the Belgian Congo, from which practically all of the world's supply of radium is now obtained.

Proposed Chilean Mining Code Permits Wider Scope

The reforms to the Mining Code of Chile proposed to Congress by the government will permit the free participation of Chileans and foreigners in the exploitation of Chile's rich deposits of marble, onyx, lapis lazuli, borates, sodium and aluminum salts, magnesia, potash, graphite, quartz, mica, bauxite, kaolin or china clay, and petroleum and hydrocarbons in solid state.

MARKET AND FINANCIAL NEWS

Dividend Disbursements for August at New High Level

DIVIDEND disbursements continue to show a highly favorable trend, the sums distributed during August by American mining and metal companies reaching the substantial total of $34,060,240, which compares with $19,866,629 for the same month last year. The generally satisfactory condition of the industry, as reflected in current returns on investments, is to be credited chiefly to the higher price level of major non-ferrous metals, notably copper.

Returns to stockholders for August, together with disbursements for comparable quarterly periods of this year as well for 1928, are shown in the following tabulation:

	1928	1929
February	$17,797,953	$21,678,018
May	17,359,998	29,830,215
August	19,866,629	34,060,240
November	19,247,397	.....

Outstanding in dividend disbursements was the showing of the copper group. Anaconda Copper Mining Company distributed $14,047,278 in August, or more than 40 per cent of the total for all companies listed in the subjoined compilation. Return to Anaconda stockholders for the year ended Aug. 31, on an annual yield basis, was 5.8 per cent, against 4.9 per cent for the similar period last year.

United Verde Extension, because of the approaching exhaustion of its ore reserves, is showing a large return on capital invested. With the stock on a quarterly dividend basis of $1 per share, at present the yield is even higher than for the twelve months just ended.

Holders of certificates for American shares of Rand Gold Mines, Ltd., received $1.51 per share during the month. A distribution of $1.52 was paid in February of the current year.

E.&M.J. Compilation of Mining Dividends and Yields for August, 1929

Companies in the United States	Situation	Per Share	Total	Per Cent Annual Yield
Anaconda Copper, c.s.l.s.	Various	$1.75Q	$14,047,278	5.8j
Bethlehem Steel Corporation	Various	1.00Q	2,402,899	3.2
Bunker Hill & Sullivan, l.s.	Idaho	0.75MX	245,250	7.1j
Colorado Fuel & Iron, pfd.	Various	2.00Q	40,000	6.0j
Freeport Texas, su.	Texas	1.00Q	729,783	9.5j
Homestake Mining, g.	S. Dakota	0.50M	125,580	9.1j
Miami Copper, c.	Arizona	1.00Q	747,134	9.3j
National Lead "B"	Various	1.50Q	154,913	5.1j
New Jersey Zinc	Various	0.50Q	981,632	2.4
United States Steel, pfd.	Various	1.75Q	7,304,919	5.0j
United Verde Extension, c.	Arizona	1.00Q	1,050,000	19.0j
Vanadium Corporation	Various	0.75Q	283,775	3.8
Companies in other countries				
Andes Copper, c.	Chile	0.75Q	2,320,000	4.2j
Amparo Mining, g.s.	Mexico	0.01Q	20,000	....
Cerro de Pasco, c.s.	Peru	1.50Q	1,684,263	5.7j
Granby Consolidated, c.	Br. Col.	1.75Q	786,386	8.3j
Hollinger Consolidated Gold	Ontario	0.05FW	246,000	10.0j
International Nickel, pfd., n.c.	Ontario	1.75Q	158,959	5.3j
Lucky Tiger-Combination, g.s.	Canada, Mex.	0.025M	17,895	10.0
Teck-Hughes, g.	Ontario	0.15Q	713,574	7.3
Total			$34,060,240	

c, copper; z, zinc; l, lead; s, silver; g, gold; n, nickel; su, sulphur; Q, quarterly; I, initial; FW, four weeks; M, monthly; MX, 25c. monthly and 50c. extra; j, based on dividends for the last 12 months.

Patiño Mines Income Up in First Half of 1929

PATIÑO Mines & Enterprises Consolidated, Inc., reports for the six months ended June 30, 1929, a net profit of $2,799,329, after interest, depreciation, depletion, and federal taxes, equivalent to $2.03 a share. This compares with $2,006,624, or $1.45 a share, in the first half of 1928.

For the quarter ended June 30, net profit was $1,870,712, after the above charges, equal to $1.36 a share, against $928,617, or 67c. a share, in the preceding quarter, and $855,399, or 62c. a share, in the June quarter of 1928.

Income account for the six months ended June 30, 1929, compares as follows:

	1929	1928
Income from mine operation	$10,613,659	$7,997,320
Production costs	6,892,074	5,065,664
Profit	$3,721,585	$2,931,656
Other income	370,181	258,819
Total income	$4,091,766	$3,190,475
Interest accrued	16,156	62,800
Bolivian income tax	298,580	171,690
Depression and deflation	977,701	949,361
Net income	$2,799,329	$2,006,624

Shares outstanding total 1,380,316, and par value is $20.

Phelps Dodge Profit for Half Year $4,481,497

For the first half of 1929 the Phelps Dodge Corporation and subsidiaries shows a profit of $4,481,497 after depreciation, federal taxes, and other charges, but before depletion, equal to $2.24 a share on 2,000,000 shares of stock. The consolidated income report for six months ended June 30, 1929, shows: Sales of metals, $17,698,990; other income, $705,907; total income, $18,404,897; costs, expenses and federal taxes, $13,255,528; depreciation, $667,872; profit before depletion, $4,481,497.

Production of copper during the six months was 117,846,431 lb. Sales to customers were 65,161,876 lb., and unsold copper, blister and refined on June 30, last, amounted to 58,298,883 lb.

Mother Lode Reports Drop in Six Months' Profit

Mother Lode Coalition Mines Company reports for the six months ended June 30, 1929, profit of $276,529 after crediting value of silver contents and deducting taxes, but before depreciation and depletion, comparing with $567,443 in the first six months of 1928.

In the first half of 1929 the company sold 3,283,833 lb. of copper and produced 6,189,563 lb., unsold copper being carried in inventory at cost of production. Average cost of producing copper delivered to the consumers was 9.913c. a pound during the first six months of the year.

REPRESENTATIVES OF THE U. S. STEEL CORPORATION are examining the properties of the Columbia Steel Corporation in Utah and California. An option held by the Steel Corporation expires on Oct. 29, 1929. The Columbia Steel Corporation operates a blast furnace and byproduct coking plant near Provo, Utah, owns coal and iron ore properties in Utah, rolling mills, open-hearth furnaces, and a tin-plating plant at Pittsburg, Calif., and other plants at Portland and in the Los Angeles area.

CONSOLIDATED MINING & SMELTING COMPANY OF CANADA has announced its earnings for the first half of this year, after providing for depreciation, depletion, taxes, and contingent account, are estimated at $4,559,943, compared with earnings, similarly computed, of $4,416,025 for the first half of 1928. The metal production was lower than in the first half of last year, but higher prices made the profit greater.

London Financial News

By W. A. Doman
Special London Correspondent

London, Aug. 15, 1929.—It is becoming fairly evident that the autumn and winter will witness more activity in promotions than has been experienced for a long time. Although a hush-hush policy seems to be pursued at the moment, it would not be surprising if the Panama Corporation were to float a subsidiary. With such a large area to explore and work, the corporation could not make much in the way of returns; neither would it be good economic policy to confine itself to developing what may be important mines, but which represent only a little scratching of the concession. The correct plan would be—and doubtless this is what the directors will decide to do—to float into a separate company the ground that has been proved, and then to test other occurrences. The Panama Corporation has a large number of unissued, or treasury, shares, and these may first be offered for subscription in the autumn.

The area on which operations are at present concentrated is the Hatillos mine. A cablegram to hand states that the lower tunnel has now been driven for a total distance of 1,368 ft. This discloses six shoots of ore, their total length being 900 ft. In these shoots the zinc and lead contents are payable throughout, and, in addition, the free gold associated with the base metals averages £2 to the ton of ore throughout the entire distance. Information to hand shows the sampling results of the last 18 ft. driven to be: Lead, 11 per cent; zinc, 16 per cent; gold, 5 dwt. to the ton; silver, 1½ oz. to the ton—over a reef width of 49 in.

In connection with prospecting activity at Tanami, in the Northern Territory of Western Australia, a private syndicate has now been formed, and Allan A. Davidson, who has spent a couple of years in the district, is one of the directors.

Asbestos has been found in so many places in Africa, and the quantities to be mined are stated to be so great, that fears are expressed as to the price if all companies get to work in earnest to meet the industrial demand. Envisaging the future, some of the producers are suggesting a conference to consider the formation of a pool, or agreement, to restrict output and control sales of the fiber. No decision has yet been reached, but some of the smaller companies would not be favorable to the idea unless they were bought out at a good price.

As the Union, Rhodesia, Katanga and some other districts have proved to be so rich in minerals, the big corporations, which are able to earn profits long before the productive stage is reached, are extending their activities further afield. At present, Tanganyika Territory is being examined. The government has received applications from the Central Mining & Investment Corporation for a concession of about 1,000 square miles; from the Dutch Billiton Company; the Nyasaland Consolidated Investment Company for coal areas in Ufipa, and from the Rhodesian Proprietary Mines. The government will appoint a Commissioner of Mines.

Profitable Six Months for International Nickel

International Nickel Company, of Canada, Ltd., and subsidiary companies, report net profit of $11,238,176 for six months ended June 30, 1929, equal to 74c. a share on common stock after allowing for preferred dividend. The earnings statement for the current year includes the Mond Nickel Company, Ltd. Net profit in the second quarter was $5,647,984, against $5,590,191 in the first quarter of this year. Consolidated general statement for the first half of 1929, with a comparison, follows:

	Six Months June 30, 1929 (a)	Six Months June 30, 1928
Earnings	$14,683,522.34	$6,996,759.05
Other income	1,005,255.23	129,488.03
Total income	15,688,777.57	7,126,247.08
Administration and general expense	1,001,925.80	394,505.23
Reserved for taxes	1,426,927.75	565,814.56
Net operating income	13,259,924.02	6,165,927.29
Depreciation and depletion	1,471,344.56	773,551.21
Interest paid and accrued	207,705.64	.....
Retirement system and insurance	342,697.75	305,854.65
Profit	11,238,176.07	5,086,521.43
Dividends, Preferred	1,073,940.11	267,378.00
Common	5,499,263.20	1,673,384.00
Balance	$4,664,972.76	$3,145,759.43

(a) Figures for the Mond Nickel Company, Ltd., included.

Consolidated Lead & Zinc Company, for the quarter ended June 30, 1929, reports a profit of $96,872 after charges, but before depreciation, depletion and federal taxes, comparing with $96,791 in the first quarter last year, making a total profit for the first half of 1929 of $193,663. The company has outstanding 250,000 shares.

Callahan Zinc-Lead Company reports for the quarter ended June 30, 1929, a loss of $7,236 after development costs, expenses, and other charges, but before depreciation and depletion, comparing with loss of $25,572 in the preceding quarter, making a loss of $32,808 for the first six months of 1929.

London Tin Syndicate proposes to increase capital to £1,000,000, from £600,000, by creating 400,000 new shares of £1 par each. Of the total, 140,000 new shares will be credited as fully paid and will be applied to the purchase of Ropp Tin, Ltd.

World's Zinc Production in July 135,969 Tons

The world's output of slab zinc in July totaled 135,969 short tons, against 134,475 tons in June and 140,379 tons in May, according to the American Bureau of Metal Statistics. Production in the United States during July was placed at 54,441 tons, and 81,528 tons was the output for the rest of the world in that month. Total production for the first seven months of the current year was 937,969 tons, against 908,955 tons in the same period last year. Daily rate of production for the seven-month period was 4,424 tons, which compares with a daily rate for the whole of 1928 of 4,308 tons.

Production of zinc for July, and for the January-July period, in tons, follows:

	July, 1929	Jan.-July, 1929
United States	54,441	372,339
Canada	6,296	51,563
Mexico	1,321	9,073
Belgium	18,400	127,808
France	8,146	59,655
Germany (a)	10,022	67,406
Great Britain	5,896	38,823
Netherlands	2,414	16,738
Poland (a)	16,876	113,240
Spain	1,120	7,458
Australia	4,826	33,106
Rhodesia	1,211	7,260
Elsewhere (b)	5,000	33,500
World's total	135,969	937,969

(a) Includes zinc dust. (b) Estimated.

Rhodesia Concession Reorganization Approved

The proposed recapitalization of Rhodesia Minerals Concession, Ltd., was unanimously approved by the shareholders at a recent extraordinary general meeting. By dissolving the original company, claims on over 12,000 square miles in the southeastern part of Northern Rhodesia, granted by the British South Africa Company, are extended to April, 1935. As a result of the recapitalization, exploration and development work is to be continued on gold, zinc and copper areas.

Witwatersrand Gold Group Reports Lower Profits

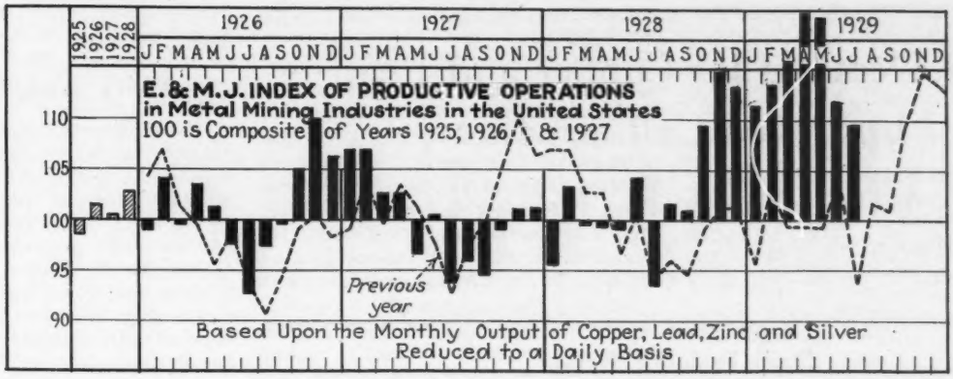
Total profits of the six groups which comprise the principal gold mines of the Witwatersrand for June, 1929, amounted to £1,062,722, a decrease of £32,724 as compared with the results for the previous month and £16,495 below the figure returned for June, 1928. For the six months of the present year the groups' profits aggregate £6,371,051, a decrease of £10,120 as compared with the total for the corresponding period of last year.

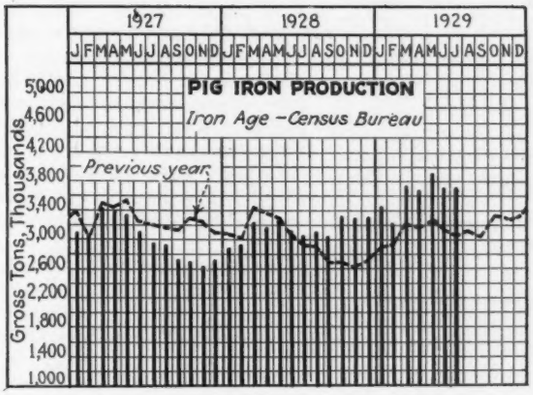
Comparative figures are:

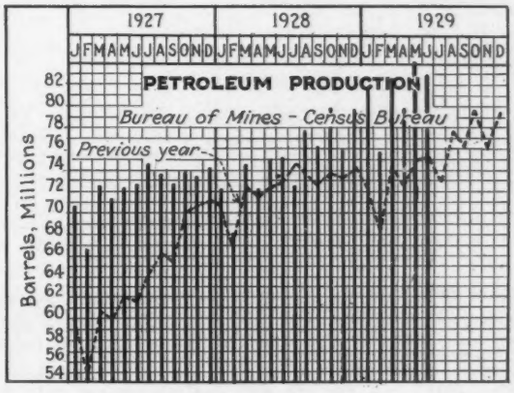
	1929		First Six Months	
	June	May	1929	1928
Barnato group	£368,424	£389,362	£2,229,812	£2,233,629
Central Mining-Rand Mines	376,396	369,424	2,164,998	2,169,035
Anglo-American Corporation	136,165	149,395	852,105	884,941
Union Corporation	106,416	112,007	647,505	635,910
New Cons. Gold Fields	48,984	53,911	343,337	402,626
Gen. Mining & Finance Corporation	26,337	21,347	133,294	75,030
Totals	£1,062,722	£1,095,446	£6,371,051	£6,381,171

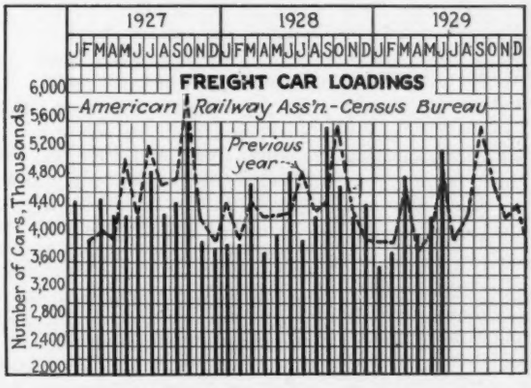
Indicators of Industrial Activity

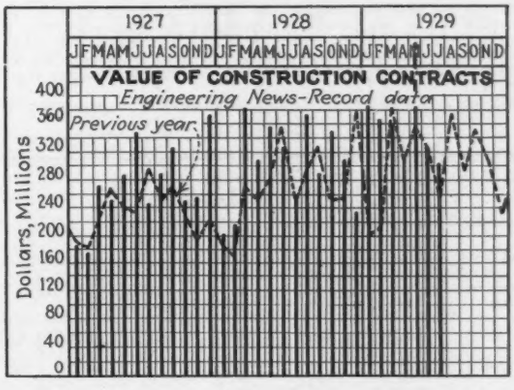
of Significance to Mining

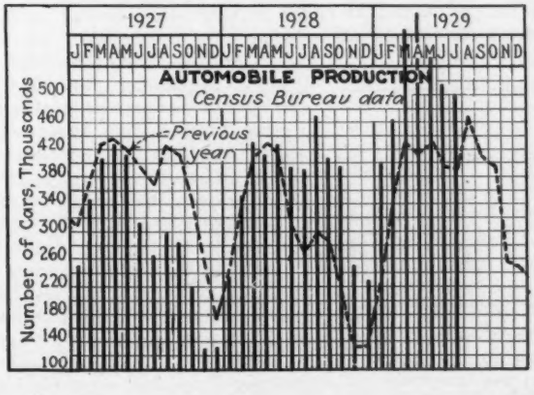

1925
1926
1927
1928
1926
1927
1928
1929
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
E. & M. J. INDEX OF PRODUCTIVE OPERATIONS
in Metal Mining Industries in the United States
100 is Composite of Years 1925, 1926 & 1927
110
105
100
95
90
Previous year
Based Upon the Monthly Output of Copper, Lead, Zinc and Silver
Reduced to a Daily Basis

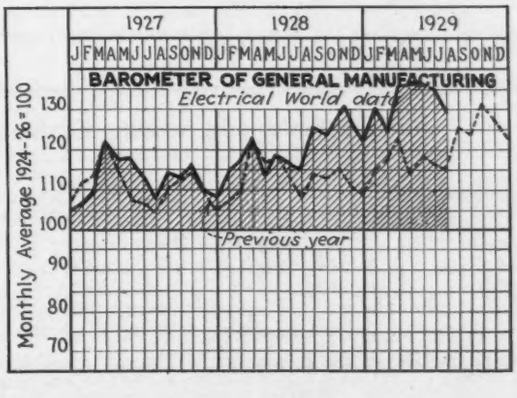











1927
1928
1929
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
BAROMETER OF GENERAL MANUFACTURING
Electrical World data
Previous year
Monthly Average 1924-26 = 100
130
120
110
100
90
80
70

The Market Report

Active Demand for Copper and Lead—Improved Call for Zinc

New York, Aug. 28, 1929.—Consumers entered the market for both copper and lead on a large scale, the week's business being greater in volume than for any similar period since early March. Demand for zinc, though not active, registered some improvement over that which obtained last week. Tin was quiet. Prices, with the exception of tin, held on a firm basis. A feature in the situation was the tendency of consumers to take on metal for shipment a little beyond immediate needs, indicating that they have more confidence in the general situation. A fair proportion of October copper and lead was bought during the week.

Daily Prices of Metals

Aug.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
22	17.775	46.50	6.75	6.55	6.80
23	17.775	46.75	6.75	6.55	6.80
24	17.775	No Market	6.75	6.55	6.80
26	17.775	46.25	6.75	6.55	6.80
27	17.775	46.125	6.75	6.55	6.80
28	17.775	46.125	6.75	6.55	6.80
	17.775	46.350	6.750	6.550	6.800

Average prices for calendar week ending Aug. 24, 1929, are: Copper, 17.775; Straits tin, 46.600; New York lead, 6.750; St. Louis lead, 6.550; zinc, 6.800; and silver, 52.667.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Aug.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic bid						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
22	73 1/16	74 11/16	84 1/2	209 3/4	213 1/2	23 1/2	23 1/4	24 15/16	25 1/4
23	73 7/8	74 1/2	84 1/4	210 1/2	214	23 3/8	23 1/4	25 1/16	25 3/8
26	73 1/16	74 1/2	84 1/4	209 1/4	213 3/8	23 1/2	23 1/4	25 1/16	25 5/16
27	73 1/4	74 1/2	84 1/4	208 3/8	212 3/8	23 5/16	23 7/16	24 7/8	25 3/16
28	73 1/4	74 9/16	84 1/4	208	212	23 5/16	23 7/16	24 13/16	25 3/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Aug.	Sterling Exchange "Checks"	Silver		Gold London	Aug.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
22	4.84 5/16	52 7/8	24 7/16	84s11 3/8d	25	4.84 5/16	52 5/8	24 5/16	84s11 1/2d
23	4.84 5/16	52 3/8	24 5/16	84s11 1/2d	27	4.84 1/4	52 3/4	24 3/8	84s11 3/8d
24	4.84 5/16	52 5/8	24 5/16	.....	28	4.84 5/16	52 5/8	24 5/16	84s11 1/2d

Average: Silver, 52.688c.; Sterling Exchange, 484.302c.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Active Trade in Copper

The volume of business booked in copper was larger than for any other week since March, the tonnage sold for domestic account amounting to some 28,000 tons. The fact that all sellers did not share proportionately in transactions for the week gave the market a more or less spotty appearance. An interesting development was the increased demand for shipment two months or so ahead, approximately 30 per cent of the copper sold being for October shipment. A moderate tonnage was sold for November shipment. All of the business was placed on the basis of 18c. per pound delivered Connecticut Valley.

Improvement in demand for copper products has been a factor in stimulating buying interest, although talk of higher prices, inspired largely by Wall Street, had some influence on consumers.

Export sales have been good this month, amounting to approximately 45,000 long tons to date. Copper Exporters, Inc., maintains its price at 18.30c. per pound, c.i.f., usual European destinations.

Huge Sales of Lead

More lead has been sold in the week ending today than in any week for almost a year, the total reported by sellers closely approaching 10,000 tons, yesterday being the most active day. All classes of consumers were represented, though cable manufacturers ranked first in the volume of orders. Considerable corroding lead was sold, partly for oxide manufacture, and chemical lead was in good demand. Battery makers did not enter the open market, but are taking good tonnages on contracts and in some instances are asking for an anticipation of shipments.

Prices are unchanged at 6½c., New York, the American Smelting & Refining contract price, and 6.55c., St. Louis, for all positions. Sellers, however, are reluctant to sell further ahead than September, for chemical lead, and October for desilverized. So far as the time of delivery is concerned, the total sales were almost evenly distributed among prompt, September, and October, indicating that consumers are buying ahead a little further than they were, doubtless anticipating a possible price advance. Though no such advance seems likely to occur this week, it must be admitted that there is better reason for an advance in lead than for another metal whose possible price trend has had more publicity. Foreign business in lead has also improved, and the London price is 6s. 3d. higher than a week ago, though no advance was recorded today, which perhaps had some effect in slowing up yesterday's active domestic market. Do-

mestic prices could easily be advanced to some extent without danger of encouraging the import of bullion.

Zinc Sales Better

Inquiry for zinc showed some improvement. Sales for the week, though not large, were greater in volume than in several weeks past. Prices held on a steady basis, producers holding uniformly at 6.80c. for Prime Western, St. Louis. Recent reports received here indicate that 65 per cent or more of the concentrate production in the Tri-State district, comprising the output of those properties normally selling through the sales agency, will close down for a week to ten days early in September.

World zinc statistics for July revealed a daily rate of production for that month of 4,386 tons, against 4,483 tons in June, and 4,149 tons in July of last year. World production for the seven months ended July 31 is placed at 937,969 tons by the A.B.M.S., a gain of 29,014 tons contrasted with the similar period last year.

Tin Very Dull

No interest has been exhibited in tin this week, either by traders or consumers, and prices have declined slightly, close to 46c., though they have been relatively firm considering the demand. Such inquiry as there has been was for prompt, forward shipments being almost entirely nominal at premiums of ½ to ¾c. for November. Foreign demand seems to have diminished recently, with the result that world visible supplies are expected to register a sizeable advance at the end of August.

Silver Quiet and Inactive

During the past week the silver market has been quiet and dull, with very little change in prices. Reports from abroad state that India was a moderate buyer; China operated both ways. The undertone is steady.

Mexican Dollars (Old Mexican pesos): Aug. 22, 40⅛c.; 23, 24, and 26, 39⅞c.; 27, 40c.; 28, 39⅞c.

Foreign Exchange

Practically no changes have occurred in the important Continental exchange rates in the last week. Closing cable quotations on Tuesday, Aug. 27, were as follows: Francs, 3.91⅞c.; lire, 5.22⅛c.; and marks, 23.81¼c. Canadian dollars, ⅝ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus. 24.30c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid. New York: Chinese brands, 9c. per lb. for spot, and 8⅞c. for Aug.-Sept. shipment from China. Cookson's "C" grade, spot, 14c.

BISMUTH—Per lb.. New York, in ton lots, $1.70. Smaller lots, $1.80 and up.

CADMIUM — Per lb., New York: 80@90c. Active demand.

IRIDIUM — Per oz., $230@$240 for 98@99 per cent sponge and powder.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 35c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $38@$40. Small lots bring up to $50. Nominal.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, $68 per oz. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less.

QUICKSILVER — Per 76-lb. flask, $125. Market firm. Small lots command the usual premiums.

Prices of Chromium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Titanium, Tungsten, Vanadium, and Zirconium are unchanged from the issue of Aug. 10.

Metallic Ores

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Wolframite, $15.75@$16.00 for future shipment. Offerings are not large, but with supplies for shipment from China somewhat freer, the tone in some quarters is slightly easier. Bolivian scheelite is held at $16. Western scheelite quoted at $16.50 for October-November delivery.

Antimony, Chrome, Iron, Manganese, Tantalum, Titanium, Vanadium, and Zircon ores are unchanged from quotations in the Aug. 10 issue.

Call for Zinc Ore Improves

Joplin, Mo., Aug. 24, 1929

Blende

	Per Ton
High	$46.35
Premium blende, basis 60%	44.00
Prime Western, basis 60%	$43.00@ 44.00
Table concentrates, 60%	41.00@ 43.00
Flotation concentrates	39.00@ 41.00
Average settling price	43.98

Galena

High	$87.85
Basis 80%	85.00
Average settling price	86.45

Shipments for the week: Blende, 13,496; lead, 1,189 tons. Value all ores the week, $696,320.

Larger purchases and shipments of zinc ore have encouraged a hope that ore prices may be quoted higher not later than mid-September.

Owners of tailing mills and mine mills, where production is diminishing, together with owners of idle mills, to a total of more than fifty, within three days responded to an advertisement when three mills were sought for removal. This is accepted as an evidence of a declining zinc ore production. These mills are for removal to a newly developing field in Missouri, midway between the Duenweg and Granby groups of abandoned mines, in a territory unexplored until this year. Prospect drillings have blocked out ore deposits over an area of several hundred acres, which may add to the zinc and lead ore production in 1930.

Platteville, Wis, Aug. 24, 1929.

Zinc Blende

	Per Ton
Blende, basis 60 per cent zinc	$46.75

Lead Ore

Lead, basis 80 per cent	$85.00

Shipments for the week: Blende, 706 tons; lead, 120 tons. Shipments for the year: Blende, 22,491; lead, 1,300 tons. Shipments for the week to separating plants, 1,766 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, and Tripoli are unchanged from prices in the Aug. 10 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic) Per lb., 4c. Good call at steady prices.

SODIUM NITRATE — Per 100 lb., $2.08 for Sept. deliveries.

Antimony Oxide, Calcium Molybdate, Copper Sulphate, Sodium Sulphate, and Zinc Oxide are unchanged from prices in the Aug. 10 issue.

Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $105. Spiegeleisen, 19@21 per cent, $32@$34 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.45 f.o.b. works.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferrovanadium, Nickel Silver, and Yellow (Muntz) Metal are unchanged from prices in the Aug. 10 issue.

Rolled Metals

Copper, Lead, Zinc, Monel Metal, and Nickel Sheets are unchanged from prices in the Aug. 10 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of Aug. 10.

Iron, Steel, and Coke

IRON—Per gross ton, Valley furnaces, Bessemer, $19; basic, $18.50; No. 2 foundry, $18.50.

STEEL—Base prices per gross ton Pittsburgh, billets and slabs, $35; plates, structural shapes, and soft steel bars, per 100 lb., $1.95.

COKE—Per gross ton, Connellsville furnace, $2.65@$2.75. Connellsville foundry, $3.75@$4.85. Byproduct coke, Ohio and Kentucky (Connellsville basis) $6.50; Buffalo and Detroit, $8.50@$9.

Mining Stocks—Weeks Ending Aug. 17 and 24, 1929

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda Copper	New York	125	95	118⅞	Jl. 13, Au. 19 Q	1.75
Andes Copper	New York	56	52⅜	53½	Jl. 13, Au. 12 Q	0.75
Arizona Com	Boston	2⅜	2½	2⅜	Jl. 16, Jl. 31 SA	0.25
Calumet & Ariz	New York	129⅜	126½	129⅜	Se.6, Se.23 Q	2.50
Calumet & Hecla	Boston	45½	43½	44¼	Au.31,Se.30 Q	1.00
Cerro de Pasco	New York	99½	94½	95½	Jl.11, Au. 1 Q	1.50
Con. Coppermines	N. Y. Curb	10⅛	9⅛	9⅞		
Copper Range	Boston	23⅞	22½	23⅜	Je. 15, Jl. 15 Q	0.50
East Butte	Boston	3½	2½	3½	Dec., 1919	0.50
Granby Con	New York	81	77½	80½	Jl.12, Au. 1 Q	1.75
Greene Cananea	New York	185	175½	185	Se.12, Oc.7 Q	2.00
Howe Sound	New York	67½	63½	63⅝	Je. 29, Jl. 15 Q	1.50
Hudson Bay	N. Y. Curb	20½	18½	18⅝		
Inspiration	New York	46⅝	42½	46	Se.9, Oc 7 Q	1.00
Isle Royale	Boston	23½	22½	23½	Au. 31, Se.30	0.50
Kennecott	New York	90	85½	89⅛	Au. 30, Oc. 1 Q	1.25
Magma Copper	New York	71½	66⅛	71½	Je.28, Jl.15 Q	1.25
Mason Valley	N. Y. Curb	1⅞	1¾	1⅞		
Miami Copper	New York	44⅛	42	44⅛	Au. 1, Au. 15 Q	1.00
Mohawk	Boston	56	53	53½	Jl. 31, Se. 2 Q	2.00
Mother Lode	New York	3⅜	3	3	Je. 13, Je. 29	0.20
Nevada Con	New York	48⅛	44½	47⅜	Je. 14, Je. 29 Q	0.75
Noranda	N. Y. Curb	66⅛	60	64½		
Ohio Copper	N. Y. Curb	1⅛	1⅛	1⅛	Sept., 1926	0.03
New Dominion	Boston	*18	*18	*18	Dec., 1918	1.00
Phelps Dodge	New York	64½	58	61⅛	Se. 4, Oc.1 Q	0.75
Quincy	Boston	49¾	44	48	March, 1920	1.00
Roan Antelope	N. Y. Curb	45½	42⅛	44		
St. Mary's M. L.	Boston	41	37	40½	Fe.25, Mr.12	2.00
Seneca Copper	New York	5	4½	5		
Shattuck Denn	N. Y. Curb	16½	14½	14⅝		
Sherritt-Gordon	Toronto	7.75	7.30	7.40		
Tenn. C. & C.	New York	18½	17	17⅛	Au.31, Se.16 Q	0.25
United Verde Ex	N. Y. Curb	18⅛	16½	18	Jl. 2, Au. 1 Q	1.00
Utah Copper	New York			301	Je. 14, Je. 29 Q	4.00
Waite-Ack.-Mont	Toronto	7.65	7.00	7.25		
Walker Mining	Salt Lake	6.40	5.40	5.55		
Wenden Copper	N. Y. Curb	1¼	1	1¼		
LEAD, ZINC, SILVER						
Ahumada Lead	New York	1⅜	1¼	1⅜		
Amer. Z. L. & S.	New York	30⅞	24½	26½	May, 1917	1.00
A. Z. L. & S., pfd.	New York	107½	95	104½	Je.14, Jl. 1	1.50
Bunker Hill & S.	N. Y. Curb	140	132	140	Ap.25, My.6 X	0.75
Butte Cop. & Zn.	New York	4⅛	3⅞	4¼		
Butte Cop. Con.	Boston Curb	*32	*25	*31½		
Butte & Sup.	New York	8⅛	8	8⅛	Je. 14, Je. 29 Q	0.50
Callahan Zn-Ld.	New York	1⅛	1⅛	1⅛	Dec., 1920	0.50
Chief Consol.	Salt Lake	3.60	3.50	3.55	Fe. 1, 1928 K	0.10
Consol. Ld. & Zn. "A"	St. Louis	*11½	*10⅛	*10⅛	Je.20, Jl.1 Q	0.25
Constitution	Spokane	*56	*53	*54		
Dayrock	Spokane	3.75	3.00	3.25	Je.20, Je.30	0.03
Dickens Consol.	Spokane	6⅛	5½	6		
Eagle-Picher	Cincinnati	*18	*16½	*17½	Je. 30, Jl.15 Q	0.20
Eagle-Pich., pfd.	Cincinnati	103	103	103	Je. 30, Jl. 15 Q	1.50
Erupcion	Boston Curb			*12	Ja. 1, 1928 Q	0.07½
Eureka Bullion	Salt Lake	1.25	1.00	1.02½		
Eureka Lily	Salt Lake			*33		
Eureka Standard	Salt Lake			1.42½		
Evans-Wallower	N. Y. Curb	18⅛	17½	17⅝		
Evans-Wal., pfd.	N. Y. Curb			84	Je.20, Jl. 1 Q	1.75
Federal M. & S.	New York			280	Je., 1927	10.00
Fed. M. & S., pfd.	New York	99¾	99¾	99¾	Au.23, Se.16 Q	1.75
Gladstone	Spokane	*7	*5½	*5½		
Golconda	Spokane	*95	*71	*71	Je.15, Jl.1	0.02
Grandview	Spokane	*40	*38	*38		
Hecla Mining	N. Y. Curb	18	17⅛	17½	Au.15,Se.15 Q	0.25
Highland-Surprise	Spokane	*15	*14½	*14½		
Jack Waite	Spokane	* 9⅜	*9	*9½		
Kootenay Florence	Spokane	*16	*14	*14		
Lucky Jim	Spokane	*9	*9	*9		
Lucky Tiger-C.	Kansas City	†3.25	†3.00		Au. 1, Au. 10	0.02½
Mexican Premier	Spokane	2.33	2.23	2.25		
National Lead	New York	154	147	150⅜	Se. 13, Se. 30 Q	1.25
Natl. Lead, pfd. A	New York	138½	138½	138½	Au.30, Se. 14 Q	1.75
Natl. Lead, pfd. B	New York	116½	116	116	Oc. 18, No. 1 Q	1.50
N. J. Zinc, new	N. Y. Curb	84½	83½	84	Jl.20, An.10 Q	0.50
New Quincy	Salt Lake	2.37½	2.22½	2.35	My.15, My.27 Q	0.10
Noble Five	Spokane	*60	*50	*50		
North Lily	Salt Lake	6.35	6.15	6.15	Jl.16, Jl.20 Q	0.25
Park Bingham	Salt Lake	7.00	6.50	6.50		
Park Utah	New York	6½	5½	5⅝	Je. 14, Jl. 10 Q	0.20
Pend Oreille	Spokane	6.25	*5.00	5.00		
Rico Argentine	Salt Lake	*36	*31	*32	No. 30, De. 15 Q	0.03
Ruth-Hope	Spokane	*35	*30	*32		
St. Joseph Lead	New York	71	66½	68⅜	Se.10,Se.20 QX	0.75
Sherman Lead	Spokane	*70½	*62	*67		
Silver King Coa	Salt Lake	12.87½	12.75	12.87½	Je. 20, Jl. 1	0.25
Silversmith	Spokane	*8⅛	*8	*8	Oct., 1926 Q	0.02
Sunshine Mining	Spokane	5.15	4.65	5.15	Je. 10, Je. 20 Q	0.05
Tamarack-Custer	Spokane	*80	*71	*79½	Sept., 1924	0.25
Tintic Standard	Salt Lake	13.75	13.50	13.75	Je. 17, Je. 29 QX	0.30
Tonopah Belmont	N. Y. Curb	1.00	.50	1.00	Oct., 1925	0.05
Treadwell-Yukon	Toronto	10.00	9.25	9.25		
United Zinc Smg	N. Y. Curb	*87½	*50	*62½		
Utah Apex	Boston	3⅛	3⅛	3⅛	May 15, June 1	0.25
Utah Met. & Tun.	Boston	1⅛	1⅛	1⅛	Dec., 1917	0.30
Whitewater	Spokane	*55	*50	*50		
Yellow Pine	Los Angeles	..	....	*8	Dec., 1925 QX	0.04
GOLD						
Alaska Juneau	New York	8⅛	6⅞	8		
Barry-Hollinger	Toronto	*30	*28	*28		
Central Manitoba	Toronto	*42	*40	*40		
Creason Consol.	N. Y. Curb	*62½	*50	*56½	Mr.30, Ap.10 Q	0.02½
Dome Mines	New York	10⅜	9⅛	10⅛	Jl. 20, Q	0.25
Golden Cycle	Col. Springs	†1.75	†1.71½	....	Au.31,Se.10 Q	0.04
Gold Hill	Toronto	...	...	1½		
Hollinger	Toronto	7.00	6.50	6.90	Au.23,Se.9 FW	0.05
Homestake	New York	93	76	93	Au.20, Au.26 H	0.50
Kirkland Lake	Toronto.	*92	*80	*81		
Lake Shore	Toronto	26.75	26.00	26.50	Je.1, Je.15 Q	0.20
McIntyre-Porc	New York	16	.15	15	Au.1, Se.2 Q	0.25
Portland	Colo.Springs	†*9	†*5	....	April, 1927	0.02
Rand Mines	New York	....	....	35	Au. 21,'29 Am.Sh.	1.51
Siscoe	Toronto	*72	*69	*71		
Sylvanite	Toronto	1.08	1.00	1.04		
Teck-Hughes	Toronto	8.15	7.75	7.80	Jl. 18, Au. 1	0.15
Tom Reed	Los Angeles	*71	*60	*71	Dec., 1926	0.02
Unity Gold	N. Y. Curb	1⅞	1	1⅛		
Vipond Consol	Toronto	*85	*80	*80	April, 1927	0.03
Wright-Hargreaves	Toronto	1.91	1.75	1.75	Oc. 16, No. 1	0.02½
Yukon-Alaska	N. Y. Curb	....	....	35½		
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	17⅛	16½	16½		
Castle-Trethewey	Toronto	*32	*30½	*30½		
Consol. Cortes	N. Y. Curb	⅛	⅛	⅛		
Dolores Esperanza	N. Y. Curb	*75	*75	*75	July, 1923	0.05
Keeley	Toronto	*47	*45	*47	Mr.15, 1928	0.04
Mining Corp.	Toronto	4.55	4.30	4.35	My.30, Je.13	0.12½
Montana-Idaho	Spokane	*7⅛	*5	*5½		
N. Y. & Hond. Ros	N. Y. Curb	....	....	17⅛	Jl.17, J1.27 QX	0.50
Nipissing	N. Y. Curb	2⅛	2⅛	2⅛	Je.29, Jl.20 Q	0.07½
Premier Gold	N. Y. Curb	1⅛	1⅛	1⅛	Je.13, Jl.3 Q	0.06
Tonopah Exten	N. Y. Curb	....	....	*10	April, 1925	0.05
Tonopah Mining	N. Y. Curb	2⅛	2⅛	2⅛	Ap. 7, Ap. 20	0.07½
United Eastern	N. Y. Curb	*43⅛	*31½	*50		
Yukon Gold	N. Y. Curb	*93¾	*75	*81½	June, 1918	0.02
IRON AND STEEL						
Bethlehem Steel	New York	140¾	120¼	139	Oc.18, No.15 Q	1.50
Beth. Steel, pfd, 7%.	New York	122½	120	120¾	Se.6, Oc.1 Q	1.75
Cleveland-Cliffs	Cleveland	98	97	97¾	Je. 6, Je. 15	5.00
Colo. Fuel & Iron	New York	69½	64⅜	67		
Colo. F. & I., 1st pfd.	New York	....	....	133	Au.10, Se.26, Q	2.00
Great Northern Iron	New York	31⅜	29½	31	Dec.15, K	2.00
Inland Steel	New York	110	93½	95	Au.15, Se. 1, Q	1.87½
Republic I. & S.	New York	125⅜	106½	125½	My. 11, Je. 1, Q	1.00
Republic I. & S., pfd.	New York	112½	110	112½	Je .12, Jl. 1, Q	1.75
Sloss-Sheffield S. & I.	New York	55⅜	54	54	Mr. 11, Mr.20, Q	1.50
Sloss-Sheff. S. & I., pfd.	New York	70	70	70	Je.20, Jl.1, Q	1.75
U. S. Steel	New York	260½	219	258½	Au. 29, Se. 28, Q	1.75
U. S. Steel, pfd.	New York	141½	139¾	141	Au. 5, Au. 30, Q	1.75
Virginia I. C. & C.	New York	20	20	20	Jan., 1924	1.50
Virginia I.C.& C., pfd.	New York	42	42	42	Jl.16, 1928	SA2.50
MISCELLANEOUS						
Aluminum Co. of Am.	N. Y. Curb	500	431	471		
Alum.Co.of Amer., pf.	N. Y. Curb	107⅜	106½	107⅜	Mr.15, Ap.1, Q	1.50
American Metal	New York	77⅛	70½	74	Au. 21, Se. 1 Q	0.75
Amer. Metal, pfd., 6%	New York	131	127	127	Au. 21, Se. 3 Q	1.50
Amer. Sm. & Ref.	New York	118⅜	113⅜	118⅜	Je. 30, Jl. 12 Q	1.00
Amer. Sm. & Ref., pfd.	New York	133½	132	132	Au. 3, Se. 1 Q	1.75
Ang. Ch. Nitrate	N. Y. Curb	39⅛	35½	36⅜		
Asbestos Corp.	Montreal	*10	*9½	*10	Jan. 1926	1.50
Asbestos Corp., pfd.	Montreal	*30½	*30	*30	De. 31, Ja. 15 Q	1.75
Consol. M. & S.	Montreal	397	380	396	Je.29,Jl.15, SAX	6.25
De Beers Consol.	New York	22	22	22	Jl. 23, Jl.26, Q	0.96
Federated Metals	N. Y. Curb	32⅜	31	32	Je.25, Jl.5 Q	0.75
Freeport Texas	New York	46⅛	41⅜	42⅜	Jl. 5, Au.1 Q	1.00
Int. Nickel Can.	New York	55⅞	49⅜	54½	Au.31, Se.30 Q	0.25
Int. Nickel, pfd.	New York			122	Jl.1, Au.1 Q	1.75
Mayflower Assoc.	N. Y. Curb	88½	82½	86½		
Metal & Mining	N. Y. Curb	20⅛	20	20⅛	Je.20, Jl.1 Q	0.30
Newmont	N. Y. Curb	217½	208½	212	Je.29, Jl.15 Q	1.00
Patiño M. & E.	New York	43	39½	41⅛	My. 31, Jn. 28	4a
So. America G. & P.	N. Y. Curb	2½	2	2		
Texas Gulf Sulphur	New York	75⅛	70	72⅛	Se.2, Se.16 Q	1.00
U. S. Sm. R. & M.	New York	55	52½	55	Jl. 5, Jl. 15 Q	0.87½
U. S. Sm. R. & M., pfd.	New York	53	51	51½	Jl. 5, Jl. 15 Q	0.87½
Vanadium Corp.	New York	86	78	84	Au,1 Au. 15 Q	0.75

Toronto Standard Stock Exchange, Toronto, courtesy the Arthur E. Moysey Co.; Salt Lake Stock Exchange, courtesy J. A. Hogle & Co. and Logan & Bryan, New York; Standard Stock Exchange, Spokane, courtesy Pohlman Investment Company.

*Cents per share. †Bid or asked. Q. Quarterly. A. Annually. SA, Semi-annually. M, Monthly. BM, Bimonthly. FW, Four weeks. K, Irregular. I, Initial. R, Resumption. X, Extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

LONDON QUOTATIONS—WEEK ENDED August 6 & 13, 1929

	High	Low	Last	Date	Amount
Alaska Mexican ($5)	20/—	20/—	20/—		
Alaska Treadwell (25)	59/6	55/—	55/—	Nov., 1926	4 p.c.(d)
Aramayo Mines (25 frs.)	62/1½	60/—	60/—	Aug., 1929	5 p.c.(c)
Burma Corp (10 rupees)	18/5½	17/9	18/4½	July 1929	9 annas*
Bwana M'Kubwa (5s)	24/3	20/4½	23/9		
Camp Bird (2s)	2/1½	1/7½	2/—	April, 1928	16⅔ p.c.
El Oro (5s)	3/1½	2/6	2/10½	Nov., 1924	2½ p.c.* (c)
Frontino & Bolivia (£)	7/6	7/1½	7/1½	Jan., 1929	3½ p.c (c)
Mexican Corpn. (£1)	16/—	15/3	15/9		
Mexico Mines of El Oro (£1)	6/—	3/9	5/—	Dec., 1926	3½ p.c.*
Mount Isa (£1)	38/1½	36/6	37/6		
N'Changa Copper Mining (£1)	70/—	66/3	67/6		
Oroville Dredging (4s)	2/1½	1/10½	2/—	Nov., 1928	31½ p.c.
Rhodesian Congo Border (£1)	210/—	195/—	202/6		
St. John del Rey (£1)	16/—	14/9	16/—	Apr., 1929	7½ p.c.
San Francisco Mines (10s)	34/10½	34/—	34/7½	June 1929	15 p.c.
Santa Gertrudis (£1)	10/—	9/6	9/9	July 1929	7½ p.c.
Selukwe (2s. 6d.)	6/6	5/9	6/6	April, 1917	1½ p.c.
S. Amer. Copper (2s.)	3/1½	2/9	2/10½	Nov. 1917	75 p.c.
Tanganyika (£1)	64/4½	57/9	64/4½	July, 1928	5 p.c.
Union Miniere du Haut-Katanga (Brussels)	11,500	10,750	11,500	April, 1929	300 fr (‡)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian francs and free of taxation. (d) U. S. Dollars. (c) July, 1929, ex ½d. return of capital. (e) on original £1 shares.